The Flavor and Fragrance High Production Volume Consortia (FFHPVC)

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February 19, 2002

Christie Todd Whitman, Administrator
US EPA
P.O. Box 1473
Merrifield, VA 22116
Attn: Chemical Right-to-Know Program

Dear Ms. Whitman:

On behalf or the member companies of the Terpene Consortium, the Flavor and Fragrance High Production Volume Consortia is pleased to submit the Test Plan and Robust Summaries for the chemical category designated the "Bicyclic Terpene Hydrocarbons" to the HPV Challenge Program, AR-201. The Terpene Consortium has chosen not to belong to the HPV Tracker System for submission of test plans and robust summaries. We are therefore submitting the test plan and accompanying robust summaries directly to EPA to make available to the public.

This submission includes one electronic copy in pdf. format. A hard copy of this submission is available upon request. The EPA registration number for the Terpene Consortium is

Please feel free to contact me with any questions or comments you might have concerning the submission at tadams@therobertsgroup.net, tadams@chemintox.com or 202-331-2325.

Sincerely,

Timothy Adams, Ph.D.
Technical Contact Person for FFHPVC

AR201-13610A

The Flavor And Fragrance High Production Volume Consortia

The Terpene Consortium

Test Plan For Bicyclic Terpene Hydrocarbons

alpha-Pinene	CAS No. 80-56-8
beta-Pinene	CAS No. 127-91-3
Camphene	CAS No. 79-92-5
cis-Pinane	CAS No. 6876-13-7
Dihydropinene	CAS No. 473-55-2
l-alpha-Pinene	CAS No. 7785-26-4
Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene	CAS No. 65996-96-5
Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene	CAS No. 65996-97-6
Turpentine gum	CAS No. 9005-90-7
Turpentine oil	CAS No. 8006-64-2

FFHPVC Terpene Consortium Registration Number [redacted]

Submitted to the EPA under the HPV Challenge Program by:
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Fax: 202-463-8998

List of Member Companies

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UNILEVER-HPC

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The HPV Challenge Test Plan for Bicyclic Terpene Hydrocarbons

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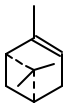
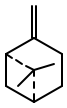


alpha-Pinene
$C_{10}H_{16}$

Synonyms:
Bicyclo[3.1.1]hept-2-ene, 2,6,6-trimethyl-
Pin-2(3)-en
2,6,6-Trimethylbicyclo[3.1.1]hept-2-ene

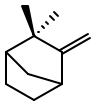
CAS No. 80-56-8



beta-Pinene
$C_{10}H_{16}$

Synonyms:
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-
Pin-2(10)-ene
6,6-Dimethyl-2-methylenebicyclo[3.1.1]heptane

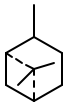
CAS No. 127-91-3



Camphene
$C_{10}H_{16}$

Synonyms:
Bicyclo[2.2.1]heptane, 2,2-dimethyl-3-methylene-
2,2-Dimethyl-3-methylenebicyclo[2.2.1]heptane

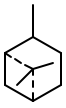
CAS No. 79-92-5



cis-Pinane
$C_{10}H_{18}$

Synonyms:
Bicyclo[3.1.1]heptane,2,6,6-trimethyl-, (1a,2b,5a)-
(1a,2b,5a)-2,6,6-Trimethylbicyclo[3.1.1]heptane

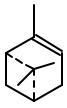
CAS No. 6876-13-7



Dihydropinene
$C_{10}H_{18}$

Synonyms:
Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-
2,6,6-Trimethylbicyclo[3.1.1]heptane

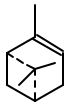
CAS No. 473-55-2



l-alpha-Pinene
$C_{10}H_{16}$

Synonyms:
Bicyclo[3.1.1]hept-2-ene, 2,6,6-trimethyl-, (1S)-
(-)-Pin-2(3)-ene
(1S)-2,6,6-Trimethylbicyclo[3.1.1]hept-2-ene

CAS No. 7785-26-4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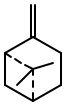
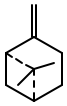


92-97% 1-7%

Terpenes and terpenoids, turpentine oil, *alpha*-pinene fraction
Synonyms: Oil of turpentine, *alpha*-pinene fraction
CAS No. 65996-96-5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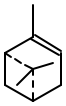
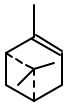

+ other terpene hydrocarbons

78-81% 8-10%

Terpenes and terpenoids, turpentine oil, *beta*-pinene fraction
Synonyms: Oil of turpentine, *beta*-pinene fraction
CAS No. 65996-97-6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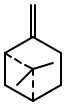
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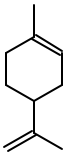
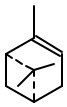

+ other terpene hydrocarbons

59% 24% 5%

Turpentine oil
Synonyms: Oil of turpentine,Turpentine
CAS No. 8006-64-2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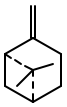

+ 5-8% other monocyclic terpene hydrocarbons

60-65% 25-35%

Turpentine gum
Synonyms: Turpentine
CAS No. 9005-90-7

2 Category Analysis

2.1 Introduction

In October of 1999, members of the United States flavor and fragrance industries as well as other manufacturers that produce source materials used in flavors and fragrances formed consortia of companies in order to participate in the Chemical Right-to-Know Program. Members of these consortia committed to assuring the human and environmental safety of substances used in flavor and fragrance products. The consortia are organized as the Flavor and Fragrance High Production Volume Consortia (FFHPVC). The Terpene Consortium, as a member of the Flavor and Fragrance High Production Volume Consortia serves as an industry consortium to coordinate testing activities for terpenoid substances under the Chemical Right-to-Know Program. Twenty-one (21) companies are current members of The Terpene Consortium. The Terpene Consortium and its member companies are committed to assembling and reviewing available test data, developing and providing test plans for each of the sponsored chemicals, and, where needed, conducting additional testing. The test plan, category analysis, and robust summaries presented represent the first phase of the Consortium's commitment to the Chemical Right-to-Know Program.

2.2 Background Information

The chemical category designated "Bicyclic Terpene Hydrocarbons" includes six simple bicyclic terpene hydrocarbons and four mixtures comprised primarily of the six bicyclic terpene hydrocarbons. These terpene hydrocarbons are extracted from plants, mainly from the resins of suitable *Pinus* species of trees. The role bicyclic terpene hydrocarbons play in the biology of plants and animals is significant. *alpha*-Pinene, a principal member of this category, is one of the most common C_{10} terpene hydrocarbons in nature. Combinations of terpenes such as *alpha*-pinene and *alpha*-terpineol have bactericidal activity while oxygenated terpene hydrocarbons formed from *alpha*-pinene (*e.g.* verbenol and myrtenal) act as natural insect pheromones.

Natural Occurrence in Food

In plants, bicyclic terpene hydrocarbons, such as *alpha*-pinene, are produced by the isoprene pathway, an integral part of normal plant biosynthesis. a*lpha*-Pinene, *beta*-pinene, pinane, camphene, and *delta*-3-carene are therefore, ubiquitous in the plant kingdom. They are common components of traditional foods occurring in essentially all fruits and vegetables [CIVO-TNO, 1999]. a*lpha*-Pinene, *beta*-pinene, pinane, *delta*-3-carene, and camphene are currently recognized by the U.S. Food and Drug Administration (FDA) as GRAS ("generally regarded as safe") for their intended use as flavoring substances [Hall and Oser, 1965]. Quantitative natural occurrence data indicate that oral intake of these substances occurs predominantly from consumption of food in which they occur naturally [Stofberg and Grundschober, 1987; Stofberg and Kirschman, 1985]. Greater than 1,000,000 pounds (lbs) of pinene (*alpha* and *beta*-pinene combined) are consumed annually as components of food in the United States. In fact, greater than a 1,000,000 lbs. of alpha-pinene is consume annually as a constituent of black pepper [Stofberg and Grundschober, 1987]. Less than 50,000 lbs are consumed as added flavoring substances [Stofberg and Grundschober, 1987]. Therefore, greater than 95% of oral intake occurs from consumption of food containing naturally occurring pinene. Based on the annual volume of consumption of pinene, it is estimated that the combined average daily *per capita* intake of *alpha*- and *beta*-pinene is approximately 10 mg/day. Intakes as high as 100 mg/day ("eaters only"- 90 percentile intake) [Oser and Hall, 1977] may be expected for consumers of diets rich in spices, fruits, and vegetables. Given that the essential oils of spices such as nutmeg, pepper, and marjoram are rich in alpha- and beta-pinene and other $C_{10}H_{16}$ bicyclic hydrocarbons such as sabinene and camphene [Bauer and Garbe, 1985], it would be expected that heavy "spice eaters" are in the "eaters only" group.

Natural Occurrence as Atmospheric Emissions

As a volatile C_{10} hydrocarbon, pinene is also a naturally occurring component of the atmosphere. Estimates of atmospheric concentrations of *alpha*- and *beta*-pinene in urban indoor air, rural outdoor air (*Pinus* forest canopy), and occupational environments (*e.g.*

sawmill or paper mill worker) have been reported to be approximately 5-10 ug/m^3 [Koistinen *et al.*, 1998; Samfield, 1992; Krause *et al.*, 1987], 500-1200 ug/m^3 [Kodama *et al.*, 1977], and 200,000-500,000 ug/ m^3, respectively [Sittig, 1977]. The Occupational Safety and Health Administration (OSHA) permissible exposure level (PEL) [Occupational Health and Environmental Control, 1974] and threshold limit value (TLV) [American Conference of Governmental Industrial Hygienists, 1993] for turpentine composed mainly of *alpha*- and *beta*-pinene is 560,000 ug/m^3. This permissible level of exposure is at least 1000 times the urban or rural atmospheric concentrations of *alpha*- and *beta*-pinene. Assuming that a human is exposed daily to an urban atmosphere containing 10 ug/m^3 *alpha*-pinene and that 60% of the inhaled *alpha*-pinene is absorbed [Falk *et al.*, 1990], the daily intake from atmospheric exposure would be approximately 0.7 mg/day 1{10 ug/m^3 x 3 m^3/hr x 24hrs/day x 0.6 (absorption rate) x 10^{-3} ug/mg}. In a rural environment in which atmospheric concentrations of *alpha*-pinene are routinely 500 ug/m^3, daily inhalation intake may approach 20 mg/day. When oral and inhalation exposures are combined, it is estimated that average total daily exposure from food consumption and normal inhalation in an urban or rural environment is in the range from 10-30 mg. However, for specialized eating groups (90 percentile of eaters, *e.g.*, spice and vegetable eaters), average daily intake may easily exceed 100 mg.

Industrial Extraction of Bicyclic Terpene Hydrocarbons from Plant Sources

The major industrial source of bicyclic terpene hydrocarbons is crude sulfate turpentine (CST) obtained from wood pulp as a waste product in the manufacturer of cellulose via the sulfate process. A minor source of bicyclic terpene hydrocarbons is wood turpentine that is obtained by the steam distillation of chopped tree trunks and dead wood. The principal constituents of all turpentine oils (CST and wood turpentine) are bicyclic terpene hydrocarbons. CST obtained from southern paper mills in the United States consists mainly of *alpha*-pinene (60-70%) and *beta*-pinene (20-25%) together with small amounts of limonene (3-10%), anethole (1-2%), and aliphatic tertiary alcohols (3-7%). In western mills, CST is composed of smaller amounts of *beta*-pinene (3-11%), but proportionately higher levels of a structurally related bicyclic hydrocarbon *delta*-3-carene (1-38%) together with a mixture of aliphatic tertiary alcohols (8-20%) [Derfer and

Traynor, 1992]. Russian and Scandinavian turpentine oil is rich in *delta*-3-carene and camphene.

2.3 Structural Classification

The chemical category designated bicyclic terpene hydrocarbons includes six simple bicyclic terpene hydrocarbons and four mixtures composed primarily of *alpha*- and *beta*-pinene and smaller amounts of the other four chemically identified terpene hydrocarbons. *alpha*-Pinene and *beta*-pinene are bicyclic monounsaturated terpenes and are positional isomers of each other. *alpha*-Pinene is 2,6,6-trimethylbicyclo[3.1.1]hept-2-ene while *beta*-pinene is 2-methylene-6,6-dimethylbicyclo [3.1.1]heptane. *l-alpha*-Pinene is the *l*-stereoisomer of *alpha*-pinene. *cis*-Pinane and dihydropinene are the saturated derivatives of *alpha*- and *beta*-pinene. They differ only in that *cis*-pinane is one of two diasterisomers of dihydropinene in which the 2-methyl is *cis*- with respect to the geminal dimethyl moiety. Camphene is also a bicyclic terpene hydrocarbon with a [2.2.1] carbon skeleton. Camphene is 3-methylene-2,2-dimethylbicyclo[2.2.1] heptane. Camphene is structurally related to *beta*-pinene in that both are bicyclic C_{10} hydrocarbons that contain an exocyclic methylene function. A structurally related C_{10} terpene bicyclic hydrocarbon found in many essential oils is sabinene or 2-methylene-5-isopropylbicyclo[3.1.0]hexane.

Of the six bicyclic terpene hydrocarbons in this chemical category, *alpha*-pinene is, by far, the most widely occurring in nature. Mixtures of (+)- and (-)- *alpha*-pinene occur in varying ratios in 60-80% concentration in American gum, sulfate, and wood turpentines. The (+)-isomer can be found in concentrations up to 95% in Turkish turpentine while the (-)-isomer predominates (90-96%) in Spanish and Austrian turpentines [Bauer and Garbe, 1985].

The four mixtures in this chemical category are all composed primarily of *alpha*- and *beta*-pinene. The combined concentration of *alpha*- and *beta*-pinene in each of these four mixtures exceeds 80%. The remaining fraction is accounted for mainly by other terpene bicyclic (camphene and carene), monocyclic (*e.g.*, limonene) and monoaromatic hydrocarbons (*e.g.*, *p*-cymene) and terpene tertiary alcohols. Two of these mixtures are

distillation products of turpentine oil. One fraction (CAS No.65996-96-5) is rich in *alpha*-pinene (92–97%) and the other (CAS No. 65996-97-6) rich in *beta*-pinene (78–81%). The other two mixtures are both variations on the common naturally occurring solvent, turpentine, varying only slightly in composition as a result of their methods of preparations. A typical analysis of turpentine oil (CAS No. 8006-64-2) includes 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene (racemic limonene), 2% each *beta*-phellandrene, *alpha*-terpineol, and linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole [Arizona Chemical, 1999]. Turpentine gum (CAS No. 9005-90-7) is composed of 60-65% *alpha*-pinene, 25-35% *beta*-pinene, and 5-8% monocyclic terpenes (limonene, etc.) [Derfer and Traynor, 1992].

2.4 Industrial and Biogenic Production

2.4.1 Industrial Production

Turpentine is a clear liquid composed of approximately 60-65% *alpha*-pinene, 25-35% *beta*-pinene with the remainder being other monocyclic terpenes such as limonene. It has been estimated that the worldwide production of turpentine is approximately 330,000 metric tons of which almost 100,000 metric tons is gum turpentine and the bulk of the remainder is crude sulphate turpentine [National Resources Institute, 1995]. In 1977, the annual United States production of CST and wood turpentine was reported to be 92,750 and 9,150 tons, respectively [McKibben, 1979]. Turpentine is derived primarily from *Pinus* species. Turpentine is used in whole form as a solvent for paints and varnishes or as a cleaning agent. Its major use however is as a source material for *alpha*-pinene- or *beta*-pinene-enriched fractions as well as the purified compounds themselves.

The purified *alpha*- and *beta*-pinenes are themselves flavor and fragrance ingredients [Hall and Oser, 1965; Opdyke, 1978]. However, by far the largest uses of *alpha*- and *beta*-pinene and the two enriched fractions are as starting materials in the synthesis of a wide range of other flavor and fragrance ingredients, such as linalool and geraniol, and medicinal products such as vitamins A and E.

Since the 1960's, natural sources of terpenes could no longer meet the world-wide demand for terpenes used in flavors, fragrances, cosmetics, vitamins, and medicines, and household products. *alpha*-Pinene and *beta*-pinene, being the primary constituents of CST produced by the paper industry, have now become the raw materials for the production of many of the commercially important terpenes. Today, *alpha*-pinene and *beta*-pinene are used to produce the vast majority of the terpenes derivatives with annual production volumes greater than 1,000,000 lbs (i.e., terpineol, linalool, linalyl acetate, nerol, geraniol, and citral).

Level-one fugacity calculations indicate that the environmental distribution of turpentine and its components is essentially entirely into the air [Trent University, 1999]. If it were conservatively assumed that through the various industrial processes approximately 2% is lost, the total annual worldwide emission of turpentine and its bicyclic hydrocarbon components would be 6,600 metric tons. This can be compared with the biogenic emissions into the air discussed below.

While discharge into the primary effluent of a pulp and paper mill has been demonstrated for *alpha*-pinene, *beta*-pinene and camphene [Koistinen *et al*., 1998] there were no detectable levels of these materials in the secondary effluent or sludge indicating a high degree of biodegradation.

2.4.2 Biogenic Production

In a recent review article [Guenther *et al*., 2000] it was said, "Natural emissions of volatile compounds are an important component of the earth system responsible for determining the composition of the atmosphere." All of the substances in this group are relatively volatile and are widely naturally occurring in plants, especially conifers [Helmig *et al.*, 1999a]. Measurements of emissions from sixty-three vegetation species in this study reported the occurrence of *alpha*-pinene, *beta*-pinene and camphene so commonly as to lead to the conclusion that these materials are practically ubiquitous in plants. In determining the impact on the environment of the industrial production and use

of the materials in this group, it is also important to examine the impact as a result of emissions from biogenic sources [Guenther *et al*., 2000].

In a recent study of the measurement of terpene emissions from *Pinus sylvestris* dominated forests [Rinne *et al*., 2000] it was reported that the main monoterpenes emitted were *alpha*-pinene, *delta*-3-carene, *beta*-pinene and camphene with *alpha*-pinene greatly dominating, 57-73%. Interestingly, it has been shown that both R and S stereoisomers of *alpha*-pinene, *beta*-pinene and camphene can be found in various parts of *Pinus sylvestris* and *Picea abies* trees [Sjödin *et al*., 2000].

By no means are the emissions *alpha*-pinene, *beta*-pinene and camphene limited to conifers. In a study of emissions over arable crops and a beech forest [Gallagher *et al*., 2000] all three were detected and some species of Mediterranean Oak have been shown to be major emitters of *alpha*- and *beta*-pinene with lesser amounts of camphene [Csiky and Seufert, 1999]. Indeed landscape flux potentials have been measured in three quite varied sites (an urban forest, a mixed deciduous and coniferous forest, and a mixed shrub oak forest) in the United States from each of 63 species of trees [Helmig *et al*., 1999a, 1999b]. All three substances were detected in a substantial proportion of the species measured with fluxes ranging from 0.1 to 80 $\mu gChr^{-1}gdw^{-1}$ (micrograms carbon per hour per gram dry weight) for *alpha*-pinene, 0.1 to 24 $\mu gChr^{-1}gdw^{-1}$ for *beta*-pinene and 0.2 to 39 $\mu gChr^{-1}$ gdw^{-1} for camphene [Helmig *et al*., 1999a]. These fluxes have been used to calculate average daily fluxes for each substance at each site [Helmig *et al*., 1999b]. For *alpha*-pinene these were 57, 150 and 39 $\mu gCm^{-2}hr^{-1}$ (micrograms carbon per m^2 per hour), for *beta*-pinene, 9, 55 and 3 $\mu gCm^{-2}hr^{-1}$ and for camphene, 32, 130 and 12 $\mu gCm^{-2}hr^{-1}$. These emissions amounted to, for *alpha*-pinene, 2.8, 3.3 and 1.6%, for *beta*-pinene, 0.4, 1.2 and 0.1% and for camphene, 1.6, 2.9 and 0.5% of the total volatile organic compounds (VOC) emissions for each of the three sites, respectively. These figures can be used to estimate the total global emissions of these materials (see below).

In a recent review of natural emissions of volatile compounds [Guenther *et al*., 2000] it was estimated that in North America the total annual emission of *alpha*-pinene, *beta*-pinene and camphene was 4.5, 3.2 and about 0.1 million metric tons, respectively. The

total global emissions of these three compounds can be estimated in two ways. The total annual global emission of VOCs has been estimated as 1150 million metric tons [Guenther *et al*., 1995]. If the same percentage of total emissions of VOCs as has been measured over 3 different forest types, 2.8, 3.3 and 1.6% for *alpha*-pinene (average = 2.6%), 0.4, 1.2 and 0.1% (0.57%) for *beta*-pinene and 1.6, 2.9 and 0.5% (1.7%) for camphene, it can be estimated that the total annual global emissions for these three substances would be approximately 30 million, 6.5 million and 19 million metric tons respectively. On the other hand, if the average rates of emission of *alpha*-pinene (82 $\mu gCm^{-2}hr^{-1}$), *beta*-pinene (22 $\mu gCm^{-2}hr^{-1}$) and camphene (58 $\mu gCm^{-2}hr^{-1}$) are applied to the latest global forest coverage estimates of 3.9 billion hectares [Food and Agriculture Organization, 2000], then annual global biogenic emissions of approximately 28 million, 7.5 million and 20 million metric tons for *alpha*-pinene, *beta*-pinene and camphene, respectively, can be calculated.

Based on the above estimates, it can be concluded that total annual atmospheric emission of *alpha*-pinene, *beta*-pinene, and camphene is predominantly from biogenic sources. The relative contribution from biogenic and industrial sources can be represented by a global emission ratio (GER = biogenic emission/industrial emission). In the case of *alpha*-pinene, *beta*-pinene, camphene, or other C_{10} hydrocarbons, the GER would exceed 1000, suggesting that biogenic emissions far exceed man-made emissions. As a result, humans are unavoidably exposed to naturally occurring bicyclic terpene hydrocarbons.

2.5 Chemical Reactivity and Metabolism

As the principal C_{10} hydrocarbon component released into the atmosphere by plants, *alpha*-pinene is rapidly absorbed by animals, distributed, metabolized to polar oxygenated metabolites and eliminated in the urine and exhaled air. As components of a traditional diet, *alpha*-pinene and *beta*-pinene, *l-alpha--*pinene, *cis*-pinane, dihydropinane, and camphene are also rapidly absorbed from the gut, metabolized and excreted primarily in the urine and, to a minor extent, in the feces. Rodent and humans studies for *alpha*-pinene, *beta*-pinene, (-)-*cis*-pinane and structurally related bicyclic terpene hydrocarbons such as *delta*-3-carene indicate that the hydrocarbons in this

chemical category participate in similar pathways of absorption, metabolism to polar oxygenated metabolites, and excretion.

2.5.1 Inhalation Pharmacokinetics in Humans

The tissue distribution, metabolism, and excretion of *alpha*-pinene have been studied in human volunteers *via* inhalation. Human volunteers were exposed to an atmosphere containing 0,10, 225, or 450 mg/m^3 of (+)-*alpha*-pinene [Falk *et al.*, 1990] or *delta*-3-carene [Falk *et al.*, 1991] for 2 hours in an exposure chamber on four occasions. Volunteers exercised on a bicycle ergometer during exposure. Total pulmonary uptake of (+)-*alpha*-pinene increased linearly with dose with 40% and 58% uptake occurring at 10 mg/m^3 and 450 mg/m^3, respectively. Uptake of *delta*-3-carene was 61% and 70% at 10 mg/m^3 and 450 mg/m^3, respectively. There was no difference in pulmonary uptake between the enantiomers (+)- and (-)-*alpha*-pinene at 450 mg/m^3. Clearance of *alpha*-pinene and *delta*-3-carene from the blood was rapid (1.1 and 0.9 L/hr/kg, respectively) indicating that *alpha*-pinene and *delta*-3-carene are rapidly metabolized. Blood levels of either substance at the two lower doses were below detection limits 4 hours after exposure. Elimination was considered triphasic with (+) and (-)-*alpha*-pinene exhibiting a rapid initial appearance phase (4.8 and 5.6 minutes, respectively), a rapid elimination phase (30 and 48 minutes, respectively) and a slow elimination phase (695 and 555 minutes, respectively). A long half-life in poorly perfused tissues indicates high affinity for adipose tissue. It was estimated that it would require 2 and 6 days to completely eliminate *alpha*-pinene and *delta*-3-carene, respectively, from the body. Less than 0.001% of the total uptake of *alpha*-pinene or *delta*-3-carene was eliminated unchanged in the urine during and immediately after exposure. There was no evidence of changes in acute lung function during or 20 minutes after exposure to *alpha*-pinene and *delta*-3-carene. The authors concluded that short-term exposure to relatively high atmospheric concentrations (greater than 100,000 mg/m^3) of *alpha*-pinene did not result in acute changes to lung function under exercising conditions.

Five humans were exposed for 4 or 6 hours to an atmospheres containing 6.4 or 3.2 ppm (24 mg/m^3 and 12 mg/m^3) of a mixture of volatile organic substances. At 6.4 ppm, the air

concentration of *alpha*-pinene was 0.139 ppm (0.775 mg/m^3). The mean pre-exposure blood concentration of *alpha*-pinene of 0.035 ppb increased to an average concentration 2.0 ppb during exposure (50-240 minutes). Thereafter (330-450 minutes), the mean blood concentration then decreased to 0.15 ppb. At 3.2 ppm exposure, changes proportional to those observed at 6.4 ppm were recorded. Similar results were also recorded for a 6-hour exposure [Ashley and Prah, 1997]. In a similar study, workers exposed for 8 hours to atmospheres containing 0.035, 070, or 0.105 ppm of *alpha*-pinene showed effective blood concentrations (average difference between blood plateau levels and pre-exposure baseline levels) of 0.94, 1.9, or 3.5 ppb [Kawai *et al.*, 1992].

2.5.2 Metabolism in Human

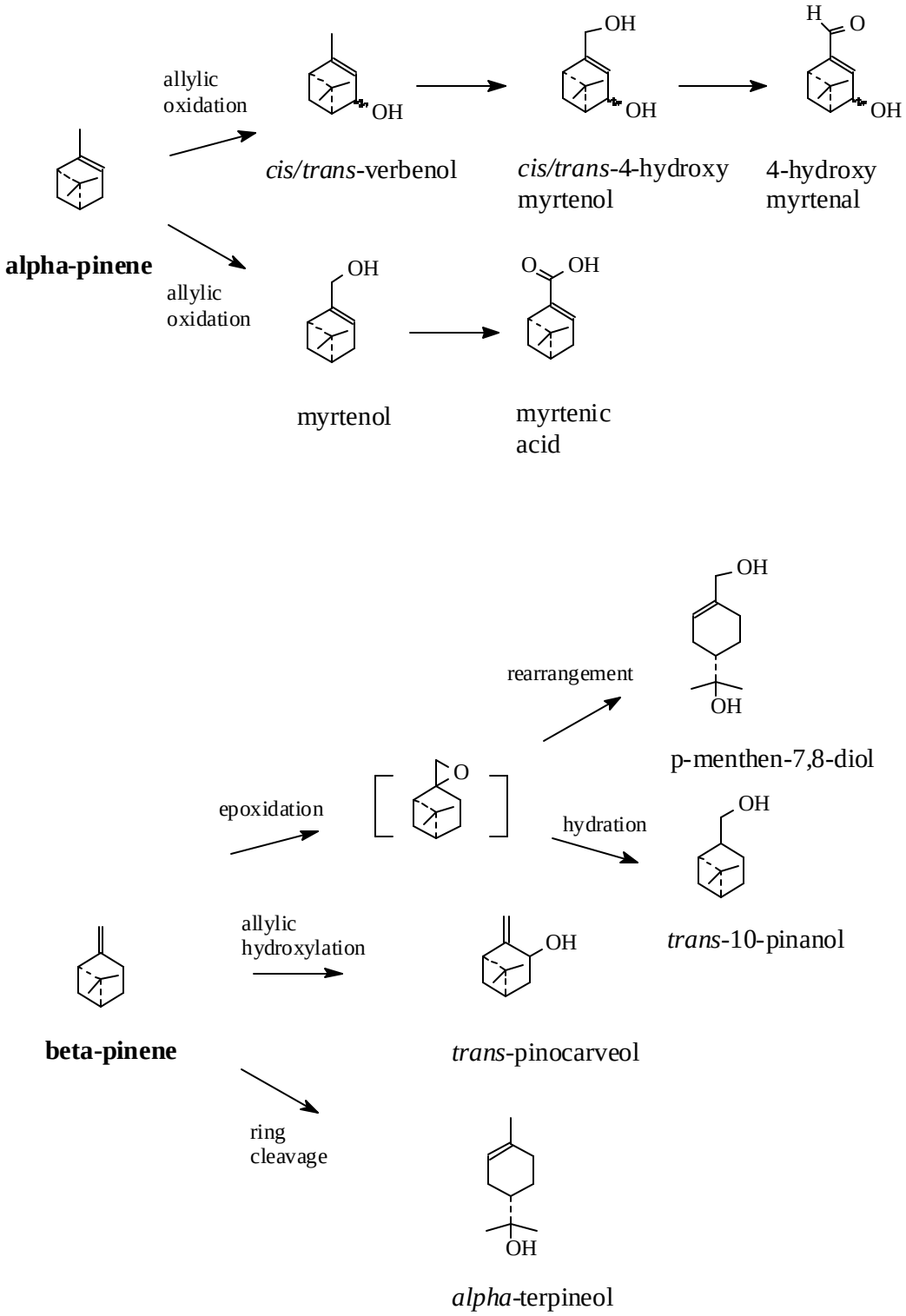
In humans, bicyclic terpene hydrocarbons are metabolized by cytochrome P-450 (CYP-450) induced C-oxidation to produce polar oxygenated metabolites that are conjugated and excreted primarily in the urine (see Figure 1). Analysis of urinary metabolites eliminated within 4 hours following a 2-hour exposure in the above pharmacokinetic study [Falk *et al.*, 1990] revealed *cis*- and *trans*-verbenol in a ratio of 1:10 with 3.8% being eliminated at 10 mg/m^3 and 1.7% at 450 mg/m^3. Most of the verbenols were eliminated within 20 hours. Respiratory elimination of (-)- and (+)-*alpha*-pinene was approximately 8% during exposure [Levin *et al.*, 1992]. Sawmill workers exposed to an atmosphere containing 40-300 mg/m^{-3} for three days showed urinary levels of 10-50 micrograms/ml of *cis* and *trans*-verbenol [Eriksson and Levin, 1990].

In a more extensive metabolic study, urine was collected from sawmill workers at the end of an 8-9 hour work shift or from chamber-exposed individuals. Following hydrolysis of glucuronic acid conjugates, *cis*- and *trans*-verbenol were identified in the urine along with two diols, *cis*- and *trans*-4-hydroxymyrtenol, formed by methyl group hydroxylation of *cis*- and *trans*-verbenol. *trans*-4-Hydroxymyrtenal was also detected (see Figure 1) [Eriksson and Levin, 1996].

Analysis of the urinary metabolites of a patient attempting suicide with 400-500 ml pine oil containing 57% *alpha*-pinene showed the presence of myrtenol, verbenol, and

borneol. Renal excretion reached a peak level 5 days after ingestion [Koppel *et al.*, 1981]. The urine of normal humans has been shown to contain *alpha*-pinene, *beta*-pinene, *delta*-3-carene, and camphene [Zlatkis *et al.*, 1973].

Figure 1 - Metabolism of alpha- and beta-Pinene in Animals



2.5.3 Metabolism in Other Animals

The metabolic detoxication of bicyclic terpene hydrocarbons in mammals is similar to that in humans. Male albino rabbits (6/group) were given a single oral dose levels of 400-700 mg/kg bw of (+)-*alpha*-pinene, (-)-*alpha*-pinene, (±)-*alpha*-pinene, (-)-*beta*-pinene, (-)-*cis*-pinane, or (+)-*delta*-3-carene. The test substance was administered by stomach tube as a suspension in a water/polysorbate 80. Animals were house individually and urine was collected daily for 3 days. Greater than 80% of each bicyclic terpene hydrocarbon was recovered in the urine as glucuronic acid conjugates of hydroxylated terpene hydrocarbons [Ishida *et al.*, 1981].

The principal metabolite formed by allylic oxidation of the exocyclic methyl group of each of the three {(+), (-), or (±)} stereochemical forms of *alpha*-pinene was verbenol (see Figure 1). Greater than 98% of (-)-*alpha*-pinene was converted to (-)-*trans*-verbenol while 67% of (+)-*alpha*-pinene was converted to racemic *trans*-verbenol. In addition, the (+)-isomer metabolized by allylic oxidation of the C_2 methyl group to yield myrtenol (15%) and small amounts of oxidized myrtenol, myrtenic acid.

The presence of an exocyclic alkene function in (-)-*beta*-pinene provides for additional metabolic options. Allylic oxidation of the C_2 position yields (+)-*trans*-pinocarveol (11%) while epoxidation of the exocyclic alkene followed by reduction or hydration yields (-)-*trans*-10-pinanol (39%) and (-)-*l-p*-menthene-1,8-diol (30%), respectively. Ring cleavage yields (-)-*alpha*-terpineol (5%) (see Figure 1).

The absence of an alkene function in (-)-*cis*-pinane and dihydropinene prohibits epoxidation. In this case, (-)-*cis*-pinane undergoes ring hydroxylation yielding 3- and 4-pinanol and verbenol and ring cleavage yielding the tertiary terpenoid alcohols (-)-*alpha*-terpineol (43%) and (-)-*trans*-soberol (6%). In a manner similar to *alpha*-pinene, *delta*-3-carene undergoes oxidation of a ring allylic position followed by ring opening to yield (-)-*m*-mentha-4,6-dien-8-ol (72%). Smaller amounts of metabolites obtained by hydroxylation at the gem-dimethyl group and allylic oxidation of the methyl group are obtained [Ishida *et al.*, 1981].

In the brushtail possum (*T. vulpecula), alpha*-pinene is metabolized to *trans*-verbenol, myrtenol, and myrtenic acid while *beta*-pinene is metabolized primarily to myrtenic acid [Southwell *et al.*, 1980]. Likewise, the *Ips* [Renwick *et al.*, 1976] and *Dendroctomus* [Hughes, 1975] bark beetles metabolize *alpha*-pinene to verbenol and myrtenol with verbenol being further oxidized to verbenone in *Dendroctomus*.

The biotransformations of *alpha*-pinene and other members of this chemical category are catalyzed by NADPH-dependent cytochrome P-450. Fractions designated CYP-450 and CYP-451 obtained from rat liver microsomes were incubated with *alpha*-pinene for 1-8 minutes intervals. Analysis of the homogenate revealed the presence of *beta*-pinene and limonene together with smaller amounts of *trans*-verbenol, myrtenol, verbenone, and pinane oxide. The proportion of oxidized metabolites was greater in P-451 than in P-450 [White and Agosin, 1980]. Terpene hydrocarbons have been found to block the metabolic activation of promutagenic substances. Both (-)-*alpha*-pinene and (+)-*alpha*-pinene produced a concentration-dependent inhibition of pentoxyresorufin-O-depentylase (a marker for the isoenzyme CYP-2B1) activity [De-Oliveira *et al.*, 1997].

In summary, humans, throughout their lifetime, are continually exposed to *alpha*-pinene, *beta*-pinene, and other terpene C_{10} hydrocarbons *via* inhalation of air or by consumption of a traditional diet. These aliphatic terpene hydrocarbons are rapidly absorbed *via* the oral route and subsequently undergo first-pass metabolism in the liver. Upon single inhalation exposure, the absorbed hydrocarbons may be distributed to adipose tissue in which case, complete clearance from the body requires days. However, taking into account the continuous intake of these substances from food and air, it is highly likely that steady state levels are maintained in humans and other animals throughout their lifetime. Clearly, bioaccumulation of these terpene hydrocarbons does not occur, since the substances are efficiently metabolized to yield oxygenated metabolites (*e.g.*, verbenol, myrtenol and myrtenic acid) that are subsequently conjugated with glucuronic acid and excreted mainly in the urine.

3 Test Plan

3.1 Chemical and Physical Properties

3.1.1 Melting Point

Literature values are available for *alpha*-pinene (-55 ^{o}C), camphene (51-2 ^{o}C), and *cis*-pinane (-53 ^{o}C) [CRC Handbook of Chemistry and Physics, 1986]. *beta*-Pinene, a positional isomer of *alpha*-pinene would be expected to have very similar physical properties and the melting point should be on the same order (-55 ^{o}C). Dihydropinene is a mixture of stereoisomers, one of which is *cis*-pinane, and therefore the melting point should be on the same order (-53 ^{o}C). *l-alpha*-Pinene is one stereoisomer of *alpha*-pinene and therefore would have the same melting point (-55 ^{o}C). The four mixtures are all primarily made up of *alpha*- and/or *beta*-pinene and therefore would be expected to have similar but lower melting points.

3.1.2 Boiling Point

Literature values are available for *alpha*-pinene (155-156 ^{o}C @ 760 mm), *beta*-pinene (165-166 ^{o}C @ 760 mm), camphene (158.5-159.5 ^{o}C @ 760 mm), *cis*-pinane (169 ^{o}C @ 760 mm) and dihydropinene (164.5-165 ^{o}C @ 760 mm) [Merck Index, 1996; CRC Handbook of Chemistry and Physics, 1986]. *l-alpha*-Pinene is one stereoisomer of *alpha*-pinene and therefore would have the same boiling point (155-156 ^{o}C @ 760 mm). The four mixtures are all primarily made up of *alpha*- and/or *beta*-pinene and therefore would be expected to have similar but somewhat lower boiling points.

3.1.3 Vapor Pressure

Calculated values [Meylan, 1994-1995c] are available and are in the range from 0.24 – 0.55 kPa at 25 ^{o}C (0.18-0.41 mm Hg) for *alpha*-and *beta*-pinene and 3.8 kPa (2.8 mm Hg) for camphene at 20 ^{o}C [Hoechst AG, 1991b]. The calculated value for camphene is based on measured values of 40 kPa and 901.1 kPa for camphene at 62.1 and 154.3 ^{o}C, respectively [Hoechst AG, 1991b]. The range of vapor pressure at ambient temperature is fairly narrow. However, vapor pressure measurement should be conducted on at least one representative member of the group, *alpha*-pinene, to confirm the model. In the event of close agreement with the calculated value, no further testing would be necessary.

3.1.4 n-Octanol/Water Partition Coefficient

There are two reports of measured log Kow values for *alpha*-pinene, the most reliable, 4.83, being from the Syracuse Research Corporation database [Li and Perdue, 1995], which compares favorably with the calculated value of 4.27 [Meylan, 1993-1995a]. The other study, which followed OECD Guideline 117, used a sample of *alpha*-pinene that also contained *beta*-pinene, *delta*-3-carene and camphene. In this study, three unidentified components of *alpha*-pinene at pH 7.5 had log Pow values above 1.5 and were reported as follows, 5.3, 5.5 and 5.7 [Dybdahl, 1993a]. A measured value is also available for the structurally related mixture containing mainly *delta*-3-carene, by the same authors. 3-Carene was reported to consist mainly of *delta*-3-carene, *alpha*-pinene, *beta*-pinene, and dipentene, but the authors provided no analytical data. The log Pow values were reported as follows for four unidentified components of 3-carene at pH 7.5: 4.6, 5.2, 5.3 and 5.5 [Dybdahl, 1993b].

For the remainder of the materials, only calculated values are available and these range from 4.35 to 4.83. The narrow range and the close agreements with the one measured value in this group indicate consistency and imply reliability. Based on the mutual agreement of measured and calculated values, no further partition coefficient studies are recommended.

3.1.5 Water Solubility

The reported water solubilities for *alpha*-pinene and *beta*-pinene are 0.65 and 2.1 mg/L at 25 °C respectively [Broderius *et al*., 1990] while the calculated values [Meylan, 1993-1995b] are 1.9 and 4.9 mg/L. The measured solubility of camphene (4.2 mg/L at 20 ^{o}C) is in the same range as for pinene [Hoechst AG, 1991c]. The close agreement between calculated and measured values gives confidence in the model used for this group. The solubility of all members of this chemical category at 25 ^{o}C is expected to be in the range from 0.50 to 6.0 mg/L. No further solubility studies are recommended.

3.1.6 New Testing Required

Vapor pressure measurements to confirm the SAR model should be conducted on at least one representative member of the group, *alpha*-pinene, in accordance with OECD Guideline 104. In the event of close agreement with the calculated value, no further testing would be necessary.

3.2 Environmental Fate and Pathways

3.2.1 Photodegradation

The calculated photodegradation half-lives [Meylan, 1994-1995b] for the structurally defined materials in this group are in the range from 1.4 to 9.4 hours. These calculations are based on measured OH rate constants for *alpha*-pinene, *beta*-pinene, camphene and *trans*-pinane, measured ozone and NO_3 rate constants with the exception of *trans*-pinane [AOPWIN]. Therefore, these figures can be considered reliable.

3.2.2 Stability In Water

No hydrolysis is possible for any of the materials in this group. All are expected to be very stable in aqueous solution.

3.2.3 Biodegradation

Five GLP experimental studies evaluating biodegradability are available for this group of substances using standard OECD Guideline protocols. Additional studies in soil horizons obtained from coniferous and deciduous forests [Misra *et al.*, 1996] provide a broader perspective on the biodegradation of bicyclic terpene hydrocarbons in the environment.

Four studies on *alpha*-pinene showed limited biodegradability. The first, which followed OECD Guideline 302C and evaluated inherent biodegradability, reported 37% biodegradation at 31 days [Rudio, 1999a]; the second, which followed OECD Guideline 301F and evaluated ready biodegradability, reported 38% biodegradation at 28 days [Rudio, 1999b]; and a third, which followed OECD Guideline 301D and evaluated ready biodegradability using a mixture mainly of *alpha* and *beta*-pinene in a closed bottle test, reported very limited biodegradability [Madsen, 1993a]. In the fourth experiment, a mixture of 50.9% *alpha*-pinene and 36.8% *beta*-pinene was concluded to be inherently biodegradable based on the results of a closed bottle Sturm test. The mixture was 52%

biodegraded within 28 days, but there was no indication that biodegradation had ceased (Long, 2001b).

Very limited biodegradability was also reported for 3-carene using an OECD Guideline 301D test protocol [Madsen, 1993b] and for camphene (less than 20%) using a standard OECD Guideline test protocol [Hoechst AG, 1988a]. In studies showing limited biodegradability, the authors concluded that the high vapor pressure and low water solubility of these substances led to volatilization of the test substance in the upper parts of the test vessel, thereby, limiting aerobic biodegradation [Rudio, 1999a; 1999b]. Calculated values by BIOWIN [Meylan, 1994a] give the same results for all of the structurally related materials, *i.e.* calculation by the linear model predicts the substances to be on the borderline between fast and slow degradation while the non-linear model predicts they will not biodegrade fast. Given the results of the experimental tests using *alpha*-pinene and *delta*-3-carene, the non-linear model appears to be the more appropriate model for this group.

Additional studies in extracts and slurries prepared from soils of coniferous and deciduous forest indicate rapid and complete biodegradation of *alpha*-pinene in a closed bottle test. Soil extracts from coniferous and hardwood watersheds were added to sealed flasks containing oxygen-saturated media that were preconditioned with *alpha*-pinene for 24 hours. *alpha*-Pinene underwent 100% biodegradation after approximately 8 days in acclimated medium and after day 15 in non-acclimated medium. The authors concluded the pinene is completely degradable in extracts prepared from watershed soils of coniferous or deciduous forests [Misra *et al.*, 1996].

3.2.4 Fugacity

Transport and distribution in the environmental were modeled using Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11 [Trent University, 1999]. The principal input parameters into the model are molecular weight, melting point, vapor pressure, water solubility, and log Kow. Where measured values were available, these were used, but where they were not, calculated data from the EPIWIN series of

programs were used. Given the similarity of the physical properties of the substances in this group, it is not unexpected that they would be predicted to exhibit similar distribution in the environment. The value of these calculations must be evaluated in the context that the substances in this chemical category are products of plant biosynthesis and are, therefore, ubiquitous in the environment.

3.2.5 New Testing Required

None.

3.3 Ecotoxicity

3.3.1 Acute Toxicity to Fish

The three principal substances in this group, *alpha*-pinene, *beta*-pinene, and camphene have measured fish acute toxicities [Broderius *et al.*, 1990]. The acute fish toxicity of a mixture of *alpha*-pinene and *beta*-pinene has also been assessed (Swarbrick, 2001).

The closeness of the 96-hour LC50 measured values for *alpha*-pinene and *beta*-pinene, 0.28 and 0.5 mg/L in fathead minnows, respectively, and the agreement of these measured values with the ECOSAR calculated ones [Nabholz and Cash, 1998], 0.22 and 0.62 mg/L, respectively, effectively validates the ECOSAR model. In a closed system flow-through test with *Brachydanio rerio* following OECD Guideline 203, camphene exhibited a 96-hour LC50 of 0.72 mg/L [Hoechst AG, 1993]. The calculated values for camphene, *cis*-pinane, dihydropinene, and *l*-*alpha*-Pinene, are 0.62, 0.63, 0.63 and 0.28 mg/L, respectively. These values indicate that all of these materials and the four mixtures that are made up primarily of these substances, should have acute fish toxicities on the order of 0.5 mg/L. The acute toxicity of a mixture of 50.9% *alpha*-pinene and 36.8% *beta*-pinene (gum turpentine) has been evaluated in rainbow trout in a modified OECD 203 Guideline test (Swarbrick, 2001). Although an 96-hour NOEC of greater than 100 mg/L was reported, the experiment was performed using water accommodated fractions in which solutions of gum turpentine were prepared by stirring appropriate weight of test substance for 23 hours followed by 1 hour settling time prior to fish being introduced. Therefore, the actual test concentrations are not known, but may assumed to be at the limit of solubility at 15^{o} C. No deaths were observed at any nominal concentration tested [Swarbrick, 2001].

3.3.2 Acute Toxicity to Aquatic Invertebrates

The two principal substances in this group, *alpha*-pinene and *beta*-pinene have measured *Daphnia magna* acute toxicities. The closeness of these 48-hour LC50 measured values,

1.44 and 1.25 mg/L [Broderius *et al*., 1990], respectively, and the agreement of these measured values with the ECOSAR 48-hour LC50 calculated ones [Nabholz and Cash, 1998], 0.22 and 0.79 mg/L, respectively, effectively validates the conservative nature of the ECOSAR model. Forty-eight hour calculated LC50 values are typically lower by an order of magnitude than experimental values.

The 48-hour LC50 values for *Daphnia magna* using pinene in lake water in a semistatic OECD Guideline 202 [Bjornestad, 1993b] and for camphene [Hoechst AG, 1980] are higher than the limit of solubility for these two substances. Therefore, these results are considered not reliable. Similarly, in an OECD Guideline 202 test, the 48-hour EC50 value for a mixture of 50.9% *alpha*-pinene and 36.8% *beta*-pinene (gum turpentine) was reported to be 10 to 100 mg/L with an NOEC value of 10 mg/L (Long, 2001a). However, this experiment was carried out with water-accommodated fractions that exceeded the limits of solubility of the test substance. However, it may be safely assumed that camphene and gum turpentine are not acutely toxic to *Daphnia magna* at their solubility limits. The calculated values for camphene, *cis*-pinane, dihydropinene, and *l-alpha*-pinene, 0.79, 0.8, 0.8 and 0.22 mg/L, respectively, indicates that all of these materials and the four mixtures that primarily are made up of these substances, should all have acute aquatic invertebrate toxicities on the order of 1.0 mg/L.

3.3.3 Acute Toxicity to Aquatic Plants

The two principal substances in this group, *alpha*-pinene and *beta*-pinene have measured algae acute toxicities [Broderius *et al*., 1990]. The 48-hour EC50 is greater than the solubility (measured as 0.65 mg/L) for *alpha*-pinene, and for *beta*-pinene it is 1.44 mg/L. The agreement of these values with the ECOSAR calculated values [Nabholz and Cash, 1998], 0.22 and 0.79 mg/L, respectively, effectively validate the ECOSAR model. The reported value of 72-hour EC50 of 1000 mg/L reported for camphene is not reliable given it far exceeds the measured solubility (4.2 mg/L) of camphene [Hoechst AG, 1991d]. Similarly, the algal (*Selenastrum capricornutum*) 72-hour EC50 value of greater than 100 mg/L (Long, 2000) exceeds the limit of solubility for a mixture 50.9% *alpha*-pinene and 36.8% *beta*-pinene (gum turpentine). However, it may be safely assumed that camphene

and gum turpentine are not acutely toxic to *Daphnia magna* at their solubility limits. The 96-hour calculated values for camphene, *cis*-pinane, dihydropinene, and *l-alpha*-pinene, 0.56, 0.57, 0.57 and 0.22 mg/L, respectively, indicates that all of these materials and the four mixtures that primarily are made up of these substances, should all have acute aquatic plant toxicity on the order of 0.5 mg/L.

3.3.4 New Testing Required

None.

3.4 Human Health Toxicity

Results of available acute toxicity tests for single exposure *via* the oral, dermal, and inhalation route provide a baseline of data to interpret the consequences of single high dose exposures occurring from intentional or unintentional poisonings or occupational accidents. The literature abounds with clinical reports of accidental and intentional acute poisoning with pinene-based turpentine [*e.g.*, Koppel *et al.*, 1981].

The requirements for further testing human health toxicity endpoints that evaluate chronic exposure must be considered in the context of the unavoidable, continuous exposure of humans to bicyclic terpenoid hydrocarbons. Humans have evolved in a biosphere in which *alpha*-pinene and other structurally related terpene hydrocarbons are ubiquitous. Conservative estimates of combined daily intake from consumption of foods and inhalation of air are in the range from 10-30 mg. For many individuals intakes may exceed 100 mg/day. Of this total exposure greater than 95% of oral intake is derived from consumption of traditional foods while greater than 98% of inhalation exposure is derived from biogenic emissions from plants. The contribution of anthropogenic sources to chronic exposure in humans is insignificant. Therefore, human health risk to *alpha*-pinene and other bicyclic terpene hydrocarbons is unavoidable. In the absence of any significant increase in the anthropogenic emissions, additional studies of repeat-dose toxicity, reproductive and developmental toxicity, and assays screening for genotoxic effects from long-term exposure seem unnecessary.

3.4.1 Acute Toxicity

Rat oral LD50 values are available for *alpha*-pinene, *beta*-pinene, camphene and turpentine oil and indicate these materials to be very low in oral acute toxicity with LD50 values in the range from 3388 mg/kg to greater than 5000 mg/kg [Moreno, 1972a, 1974a, 1975a; Piccirillo, 1984; von Skramlik, 1959]. Rabbit dermal LD50 values similarly indicate very low toxicities with values greater than the limit doses of 2000 or 5000 mg/kg [Moreno, 1972b, 1972c, 1974b, 1975b]. The remaining materials are expected to

have similar values. Acute inhalation toxicity has been measure in different animal species. The acute LC50 was reported to be 13,500 mg/m^3 in rats, 13,500 mg/m^3 in guinea pigs, and 9000 mg/m^3 in mice [Kohn, 1962]. The acute inhalation LC50 of commercial grade turpentine in Wistar rats is reported to be in the range of 12,000-20,000 mg/m^3 for 1 to 6 hour exposures and the LC50 for a 2-hour exposure in Swiss-Webster mice is 29,000 mg/m^3 [Sperling *et al.*, 1967]. Based on these results the acute oral, dermal, and inhalation toxicities of bicyclic terpene hydrocarbons is concluded to be low.

3.4.2 Genetic Toxicity

3.4.2.1 *In vitro* Genotoxicity

In vitro genotoxicity assays available for *alpha*-pinene, *beta*-pinene and camphene demonstrate that these substances have a little, if any, genotoxic potential. In standard Ames assays of *alpha*-pinene, *beta*-pinene and camphene, *Salmonella typhimurium* strains TA97, TA98, TA100, TA1535, TA1537, and TA1538 provided no evidence of mutagenicity at any dose tested [Rockwell and Raw, 1979; Florin *et al*., 1980; Heck *et al*., 1989; Jagannath, 1984; DeGraff, 1983; Connor *et al.*, 1985].

In an *in vivo-in vitro* study designed to investigate the mutagenicity of the metabolites of *alpha*-pinene and camphene, Sprague-Dawley rats were administered a single dose of 0.5 ml (452 mg) of *alpha*-pinene or camphene by gavage and the urine was collected for 24 hours. To assess the genotoxic potential of urinary metabolites, the urine extract was treated with *beta*-glucuronidase to hydrolyze glucuronic acid conjugates. The substances, the urine samples (500 microliters), the ether extracts of the urine, and the aqueous fractions of the urine-ether extracts were then separately incubated with *Salmonella typhimurium* strains TA98 and TA100 with S9 activation. *alpha*-Pinene, camphene (tested directly) and the urinary solutions isolated from the rats administered 0.5 ml of *alpha*-pinene did not show any evidence of mutagenicity in either TA98 or TA100 with metabolic activation. Assays of the ether extract of the urine from animals administered 0.5 ml camphene showed a weak response in TA100 with metabolic activation, but both

the urine sample directly and the aqueous fraction of the urine-ether extract did not [Rockwell and Raw, 1979].

In a Ames assay with camphene itself, there were no effects on several strains of *Salmonella typhimurium*, including TA100, with or without activation [Connor *et al*., 1985]. Similarly, *alpha*-pinene did not induce unscheduled DNA synthesis in rat hepatocytes [Heck *et al*., 1989] and neither *beta*-pinene nor camphene gave any evidence of sister chromatid exchange in cultured Chinese hamster ovary cells [Sasaki *et al*., 1989]. Therefore, all members of this chemical category are expected to show no significant genotoxic potential *in vitro*.

3.4.2.2 *In vivo* Genotoxicity

An *in vivo* mouse micronucleus assay using an OECD Guideline 474 protocol has been performed with camphene [Hoechst AG, 1991e]. In this study, groups of male and female (5/sex/group) were given a single oral dose of 0 or 4000 mg/kg bw of camphene by gavage. There was no increase in the incidence of micronucleated polychromatic erythrocytes in the treatment group compared to controls. Based on the results of this *in vivo* genotoxicity assay and the lack of any evidence of genotoxicity for numerous *in vitro* assays with and without metabolic activation, it is unlikely that any of these materials would exhibit a significant genotoxic potential *in vivo*. No additional *in vitro* and *in vivo* assays are requested for this chemical category.

3.4.3 Repeat Dose Toxicity

A 28-day repeat dose study has been performed with camphene according to an OECD Guideline 407 in both sexes of Wistar rats [Hoechst, 1991f]. Groups of animals (5/sex/group) were given daily oral doses of 0, 62.5, 250, or 1000 mg/kg bw by gavage for 28 days. Weekly measurement of body weight and food intake revealed no significant differences between test and control animals. Animals of both sexes at the 1000 mg/kg bw/day dose exhibited vacuolization of hepatocytes and increase liver weights. Male rats also exhibited *alpha*-2-microglobulin-type nephrotoxicity at all dose levels.

The renal pathology reported in F344N male rats is a sex- and species-specific phenomenon. The following interpretation of the nephrotoxicity reported in the 28-day study with camphene is based on recent key studies referenced below. No robust summaries have been prepared for these studies because they investigate the various aspects for the mechanism of action of *alpha*-2-microglobulin-induced nephrotoxicity.

It is now well recognized that renal lesions observed in above study, resulted from the accumulation of aggregates of *alpha*-2-microglobulin (a low molecular-weight protein synthesized in the liver) and camphene or its metabolites in the P2 segment of the renal proximal tubule. This phenomenon has only been observed in the male F344/N rat [Strasser *et al*., 1988; Borghoff *et al*., 1990]. The gene that encodes *alpha*-2-microglobulin has been isolated and the sequence deduced [Untermann *et al*., 1981]. These proteins are expressed in the liver under hormonal control [Roy and Neuhaus, 1967; Wang and Hodgetts, 1998]. *alpha*-2-Microglobulin belongs to the microglobulin super family of proteins that are characterized by a unique hydrophobic binding pocket. The lesions do not develop in the female F344/N rat or in humans [Bucher *et al*., 1986]. Subsequent investigations have shown that the *alpha*-2-microglobulin nephropathy found in the F344/N male rat does not develop in mammals that do not express the hepatic form of *alpha*-2-microglobulin [Swenberg *et al.*, 1989] such as other strains of rats [Dietrich and Swenberg, 1991], mice [Bucher *et al*., 1986; Lehman-McKeeman and Caudill, 1994] and dogs [Webb *et al*., 1990]. Therefore, the nephrotoxicity observed in the camphene study in male F344 rats is not relevant to the human health risk assessment. Based on liver toxicity, the NOAEL for this study is concluded to be 250 mg/kg bw/day.

Several repeat dose inhalation studies on the related substance turpentine are available. These studies were performed using Beagle dogs, Sprague-Dawley rats, English strain guinea pigs, Long-Evans hooded rats and Swiss white mice exposed to 2.4 or 4.8 mg/L turpentine vapor for six hours each day, five days per week for 30-84 days [Kay, 1963; Calandra, 1964]. Some toxic effects were reported, but are hard to evaluate given the lack of controls, and single dose design. These results are not considered reliable.

A 90-day repeat-dose toxicity test is available for polyterpene, which is a resin of *beta*-pinene. The test material was not analyzed for the presence of the monomer, *beta*-pinene. Therefore, the study must also be regarded as unreliable. Five groups of 20 Sprague-Dawley male and female albino rats each were administered in corn oil 0.01, 0.05, 0.2, 1.0 and 5.0% polyterpene, corresponding to 5.82, 29.58, 116.5, 586.2 or 2788.7 mg/kg bw/d, in the diet for 90 days. Observations included growth, food consumption, mortality, and status of hematopoietic and urinary systems. All animals were sacrificed at the conclusion of the study, and necropsies were performed on all animals. Histopathological examinations were conducted on selected animals from the control and test groups. No differences were seen between the test and control animals for the following parameters: growth, food consumption and utilization, mortality, hematologic and urine analyses, gross pathologic findings and histopathological findings. Elevated liver weights were reported for the two highest-level treatment groups. One male from the 0.05% and one male from the 1.0% test groups died during the study. These deaths were attributed to respiratory illness. Statistically significant differences in liver weights were reported for 1% and 5% treatment groups. Histopathological examination revealed no differences between test and control animals. Under the conditions of this study, the NOAEL is considered to be 116.5 mg polyterpene/kg bw/day [Calandra, 1962].

The repeat-dose study for camphene provides a NOAEL of 250 mg/kg bw/day [Hoechst AG, 1991f]. It is expected that *alpha*- and beta-pinene, if subjected to a 28-day study at similar dose levels would exhibit *alpha*-2-microglobulin nephrotoxicity in male rats and would be expected to exhibit a NOAEL of at least 250 mg/kg bw/day.

3.4.4 Reproductive Toxicity

In a Food and Drug Administration-sponsored study [Morgareidge, 1973a, 1973b, 1973c] that evaluated both reproductive and developmental toxicity parameters, an essential oil consisting predominantly (80-90%) of bicyclic terpene $C_{10}H_{16}$ hydrocarbons {*alpha*-pinene (20-25%), *beta*-pinene (15-18%) and sabinene (38-42%)} was given to pregnant CD-1 mice, Wistar rats, or golden hamsters. In the mouse study, groups (20-21/group) of pregnant female CD-1 outbred mice were given 0, 6, 26, 120, or 560 mg/kg bw of the test

material (FDA 71-28) by gavage in corn oil on days 6-15 of gestation. A positive control group received 150 mg/kg bw/day of aspirin. Maternal body weights were recorded on days 0, 6, 11, 15, and 17 of gestation. Females were observed daily for appearance and behavior. Food consumption and body weight were monitored to eliminate any abnormalities that may be associated with anorexia in pregnant females. On Day 17 all dams were subjected to Caesarian section and the number of implantation sites, resorption sites, live fetuses, dead fetuses, and body weight of live pups were recorded. Gestation index, mortality, number of implantation sites, number of corpora lutea, litter size and weights, sex and sex ratio of pups, and gross abnormalities to pups were reported. The urogenital tract of each dam was examined for anatomical abnormalities. One-third of fetuses of each litter underwent detailed visceral examination at 10x magnification. The remaining two-thirds were stained with alizarin red S dye/KOH and examined for skeletal defects.

The administration of up to and including 560 mg/kg bw/day of test article FDA 71-28 to pregnant mice on days 6 through 15 of gestation had no effects on nidation, reproduction, maternal survival or any measured fetal parameter. The number and types of abnormalities seen in tissues of the dam or pups of the test groups did not differ for the number and type occurring spontaneously in the positive or negative controls.

The rat and hamster studies use the same study protocol. Adult female Wistar or golden hamsters were individually housed in mess-bottom cages in a temperature- and humidity-controlled room. There were mated with untreated young adult males and observation of vaginal sperm plugs (rats) or appearance of motile sperm in vaginal smears (hamsters) was considered day 0 of gestation. Groups (22-23/dose) of pregnant Wistar rats were then given 0, 3, 2, 56, or 260 mg/kg bw of the test material (FDA 71-28) by gavage in corn oil daily on Day 6 and through Day 15 of gestation [Morgareidge, 1973c]. Groups (26-28/dose) of pregnant hamsters were given 0, 6, 28, 130, or 600 mg/kg bw of the test material (FDA 71-28) by gavage in corn oil daily on Day 6 and through Day 10 of gestation [Morgareidge, 1973b]. In the rats or hamster study, a positive control group received 250 mg/kg bw/day of aspirin.

The administration of up to and including 260 mg/kg bw/day of test article FDA 71-28 to pregnant rats on days 6 through 15 of gestation or administration of up to and including 600 mg/kg bw/day to pregnant golden hamsters on Day 6 through 10 of gestation had no effects on nidation, reproduction, maternal survival or any measured fetal parameter.

In the three-species study, no reproductive effects were observed when dose levels of up to 260 to 600 mg/kg bw of an essential oil predominantly composed of bicyclic terpene hydrocarbons (*alpha*-pinene, *beta*-pinene, and sabinene) was administered daily to mice, rats, or hamsters during gestation. When this data is combined with the fact that no adverse effects were observed to the reproductive organs in a 28-day study with camphene [Hoechst AG, 1991f] at dose levels up to 250 mg/kg bw/day, it is concluded that bicyclic terpene hydrocarbons including *alpha*-pinene and *beta*-pinene are not reproductive toxicants.

3.4.5 Developmental/Teratogenicity Toxicity

A developmental screening test is available on a commercial mixture containing *alpha*- and *beta*-pinene (17%) and camphene (5%) [Hasegawa and Toda, 1978]. In this study, a maternal and fetal NOAEL for the mixture was determined to be 0.8 ml/kg (688 mg/kg bw) while mild signs of toxicity in terms of decreased bodyweights were seen at 1.6 ml/kg (860 mg/kg bw). There were no gross, visceral or skeletal anomalies seen at the highest dose level. This could be considered a screening test for *alpha*- and *beta*-pinene at 17% of the daily dose and for camphene at 5% of the daily dose.

In a developmental study performed according to an OECD Guideline 414, Sprague-Dawley rats were given daily oral doses of 0, 250, or 1000 mg/kg bw/ day of camphene on days 6-15 of gestation [Hoechst AG, 1992]. Temporary clinical symptoms in dams at the 1000 mg/kg bw level included reduced motor activity and salivation on days 1 and 2 of treatment. No teratogenic effects were reported in any offspring. The maternal and developmental NOAEL were reported to be 250 and 1000 mg/kg bw/day, respectively.

In the FDA sponsored study discussed above [Morgareidge, 1973a, 1973b, 1973c], female pregnant CD-1 mice, Wistar rats, and golden hamsters were given dose levels of

up 560, 260, and 600 mg/kg bw, respectively, of an essential oil containing > 80% bicyclic terpene hydrocarbons daily by gavage during gestation. Based on clinical observations and measurement of body weight gain, mortality, and evaluation of the urogenital tract of pregnant females there were no signs of maternal toxicity at any dose level in any of the three species. Based on measurement of fetal survival, fetal body weight, visceral examination of pups, and a complete skeletal examination of pups at all dose levels, there was no evidence of developmental toxicity at any dose level in any of the three species.

Based on the NOAELs for maternal and developmental toxicity in studies with camphene (250 and 1000 mg/kg bw/day) [Hoechst AG, 1992] and a terpene hydrocarbon mixture containing *alpha*- and *beta*-pinene and camphene (688 mg/kg bw/day) [Hasegawa and Toda, 1978], and the lack of any signs of maternal or developmental toxicity in a mice, rats, or hamsters given 260 to 600 mg/kg bw/day of a mixture composed primarily (>80%) of *alpha*- and *beta*-pinene and sabinene [Morgareidge, 1973a, 1973b, 1973c], it is concluded that bicyclic terpene hydrocarbons are not maternal or developmental toxicants.

3.4.6 New Testing Required

None.

3.5 Test Plan Table

Chemical	Chemical and Physical Properties				
	Melting Point	**Boiling Point**	**Vapor Pressure**	**n-Octanol/Water Partition Coefficient**	**Water Solubility**
CAS No. 80-56-8 *alpha*-Pinene	A	A	Test, Calc, R	A, Calc, R	A, Calc
CAS No. 127-91-3 *beta*-Pinene	A	A	Calc	Calc	A, Calc
CAS No. 79-92-5 Camphene	A	A	A, Calc	Calc	A, Calc
CAS No. 6876-13-7 *cis*-Pinane	A	A	Calc	Calc	Calc
CAS No. 473-55-2 Dihydropinene	A	A	Calc	Calc	Calc
CAS No. 7785-26-4 *l-alpha*-Pinene	A	A	Calc	Calc	Calc
CAS No. 65996-96-5 Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction	R	R	Calc	Calc	Calc
CAS No. 65996-97-6 Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction	R	R	Calc	Calc	Calc
CAS No. 9005-90-7 Turpentine gum	R	R	Calc	Calc	Calc
CAS No. 8006-64-2 Turpentine oil	R	R	Calc	Calc	Calc

Chemical	Environmental Fate and Pathways			
	Photodegradation	**Stability in Water**	**Biodegradation**	**Fugacity**
CAS No. 80-56-8 *alpha*-Pinene	Calc	NA	A, Calc, R	Calc
CAS No. 127-91-3 *beta*-Pinene	Calc	NA	Calc	Calc
CAS No. 79-92-5 Camphene	Calc	NA	A, Calc	Calc
CAS No. 6876-13-7 *cis*-Pinane	Calc	NA	Calc	Calc
CAS No. 473-55-2 Dihydropinene	Calc	NA	Calc	Calc
CAS No. 7785-26-4 *l-alpha*-Pinene	Calc	NA	Calc	Calc
CAS No. 65996-96-5 Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction	Calc	NA	Calc	Calc
CAS No. 65996-97-6 Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction	Calc	NA	Calc	Calc
CAS No. 9005-90-7 Turpentine gum	Calc	NA	A, Calc	Calc
CAS No. 8006-64-2 Turpentine oil	Calc	NA	Calc	Calc

Chemical	Ecotoxicity		
	Acute Toxicity to Fish	**Acute Toxicity to Aquatic Invertebrates**	**Acute Toxicity to Aquatic Plants**
CAS No. 80-56-8 *alpha*-Pinene	A, Calc	A, Calc	A, Calc
CAS No. 127-91-3 *beta*-Pinene	A, Calc	A, Calc	A, Calc
CAS No. 79-92-5 Camphene	A, Calc	A, Calc	A, Calc
CAS No. 6876-13-7 *cis*-Pinane	Calc	Calc	Calc
CAS No. 473-55-2 Dihydropinene	Calc	Calc	Calc
CAS No. 7785-26-4 *l-alpha*-Pinene	Calc	Calc	Calc
CAS No. 65996-96-5 Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction	Calc	Calc	Calc
CAS No. 65996-97-6 Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction	Calc	Calc	Calc
CAS No. 9005-90-7 Turpentine gum	A, Calc	A, Calc	A, Calc
CAS No. 8006-64-2 Turpentine oil	Calc	Calc	Calc

Chemical	Human Health Toxicity					
	Acute Toxicity	**Genetic Toxicity *In Vitro***	**Genetic Toxicity *In Vivo***	**Repeat Dose Toxicity**	**Repro-ductive Toxicity**	**Develop-mental Toxicity**
CAS No. 80-56-8 *alpha*-Pinene	A	A	R	R	A	A
CAS No. 127-91-3 *beta*-Pinene	A	A	R	A	A	A
CAS No. 79-92-5 Camphene	A	A	A	A	A	A
CAS No. 6876-13-7 *cis*-Pinane	R	R	R	R	R	R
CAS No. 473-55-2 Dihydropinene	R	R	R	R	R	R
CAS No. 7785-26-4 *l-alpha*-Pinene	R	R	R	R	R	R
CAS No. 65996-96-5 Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction	R	R	R	R	R	R
CAS No. 65996-97-6 Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction	R	R	R	R	R	R
CAS No. 9005-90-7 Turpentine gum	R	R	R	R	R	R
CAS No. 8006-64-2 Turpentine oil	A	R	R	R	R	R

Legend	
Symbol	**Description**
R	Endpoint requirement fulfilled using category approach, SAR
Test	Endpoint requirements to be fulfilled with testing
Calc	Endpoint requirement fulfilled based on calculated data
A	Endpoint requirement fulfilled with adequate existing data
NR	Not required per the OECD SIDS guidance
NA	Not applicable due to physical/chemical properties
O	Other

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The Flavor and Fragrance High Production Volume Consortia

The Terpene Consortium

Robust Summaries for Bicyclic Terpene Hydrocarbons

alpha-Pinene	CAS No. 80-56-8
beta-Pinene	CAS No. 127-91-3
Camphene	CAS No. 79-92-5
cis-Pinane	CAS No. 6876-13-7
Dihydropinene	CAS No. 473-55-2
l-alpha-Pinene	CAS No. 7785-26-4
Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene	CAS No. 65996-96-5
Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene	CAS No. 65996-97-6
Turpentine gum	CAS No. 9005-90-7
Turpentine oil	CAS No. 8006-64-2

FFHPVC Terpene Consortium Registration Number [redacted]

Submitted to the EPA under the HPV Challenge Program by:
The Flavor and Fragrance High Production Volume Chemical Consortia
1620 I Street, NW, Suite 925
Washington, DC 20006
Phone: 202-331-2325
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List of Member Companies

Arizona Chemical

BASF Corporation

Bedoukian Research, Inc.

Boise Cascade Corporation

Champion International Corporation

Citrus and Allied Essences, Ltd.

DRAGOCO

Fragrance Resources, Inc.

Givaudan Fragrances Corporation

Hercules Incorporated

International Flavors & Fragrances, Inc.

J. Manheimer, Inc.

Kuraray Co., Ltd.

Mead Corporation

Millennium Specialty Chemicals

Polarome International Incorporated

Quest International

Sensient Flavors Inc

TECNAL Corporation

The Proctor and Gamble Co.

Unilever-HPC

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The Flavor and Fragrance High Production Volume Consortia

Robust Summaries for Bicyclic Terpene Hydrocarbons

The evaluation of the quality of the following data uses a systematic approach described by Klimisch [Klimisch *et al*., 1996]. Based on criteria relating to international testing standards for categorizing data reliability, four reliability categories have been established. The following categories are:

- Reliability code 1. Reliable without restrictions
- Reliability code 2. Reliable with restrictions
- Reliability code 3. Not reliable
- Reliability code 4. Not assignable

1 Chemical and Physical Properties

1.1 Melting Point

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	Measured
GLP	No
Melting Point	-55 °C
Decomposition	No
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
GLP	No
Melting Point	-55 °C

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The data are estimated based on a closely related material, *alpha*-pinene.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	ASTM E 328-79(89)
Melting Point	45 - 47 °C
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from an acceptable standardized test method.
References	Hoechst AG (1991a) Product information Camphen der Abt. Marketing Chemikalien. Unpublished Report.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	Measured
Remarks for Test Conditions	Substance supported under SIDS.
GLP	No
Melting Point	51-52 °C
Sublimation	Yes
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Method/guideline	Measured
GLP	No

Melting Point	-53 °C
Decomposition	No
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	Dihydropinene
CAS No.	473-55-2
Method/guideline	Measured
GLP	No
Melting Point	-53 °C
Decomposition	No
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The substance would be expected to have virtually identical physical properties to *cis*-pinane.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Method/guideline	Measured
GLP	No
Melting Point	-55 °C
Decomposition	No
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The substance would have identical physical properties to *alpha*-pinene.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction
CAS No.	65996-96-5
Method/guideline	Measured
Remarks for Test Conditions	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
GLP	No
Melting Point	-55 °C
Decomposition	No
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The substance would be expected to have very similar physical properties to *alpha*-pinene.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction
CAS No.	65996-97-6
Method/guideline	Measured
Remarks for Test Conditions	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta* phellandrene, 0-2% terpinolene
GLP	No
Melting Point	-55 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Method/guideline	Measured
Remarks for Test Conditions	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.).
GLP	No

Melting Point	-55 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Method/guideline	Measured
Remarks for Test Conditions	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
GLP	No
Melting Point	-55 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

1.2 Boiling Point

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	Measured
Boiling Point	155-156 °C
Pressure	760
Pressure Unit	mm
Decomposition	No
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable.

References	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	Measured
GLP	No
Boiling Point	165-166 °C
Pressure	760
Pressure Unit	mm
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable.
References	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	DIN 51751
Remarks for Substance	Technical grade
Boiling Point	156.5 - 159 °C
Pressure Unit	101.3 kPa (760 mm Hg)
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from an acceptable standardized test method.
References	Hoechst AG (1991a) Product information Camphen der Abt. Marketing Chemikalien. Unpublished Report.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	Measured
GLP	No
Remarks for Substance	Substance supported under SIDS.
Boiling Point	158.5-159.5 °C

Pressure	760
Pressure Unit	mm
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable.
References	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Method/guideline	Measured
GLP	No
Boiling Point	169 °C
Pressure	760
Pressure Unit	mm
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	Dihydropinene
CAS No.	473-55-2
Method/guideline	Measured
GLP	No
Boiling Point	164.5-165 °C
Pressure	760
Pressure Unit	mm
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable.
References	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Method/guideline	Measured
GLP	No
Boiling Point	155-156 °C
Pressure	760
Pressure Unit	mm
Decomposition	No
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable.
References	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction
CAS No.	65996-96-5
Method/guideline	Measured
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Boiling Point	155-156 °C
Pressure	760
Pressure Unit	mm
Decomposition	No
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The data are considered to be essentially the same as for *alpha*-pinene.
References	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction
CAS No.	65996-97-6
Method/guideline	Measured
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene

Boiling Point	165-166 °C
Pressure	760
Pressure Unit	mm
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The data are considered to be essentially the same as for *beta*-pinene.
References	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Method/guideline	Measured
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Boiling Point	155-156 °C
Pressure	760
Pressure Unit	mm
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
References	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Method/guideline	Measured
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Boiling Point	155-156 °C
Pressure	760
Pressure Unit	mm
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained from a recognized source and are considered reliable. The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.

References	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

1.3 Vapor Pressure

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.55 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical structure.
References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.35 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical structure.
References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Technical grade
Method/guideline	Dynamic Method
GLP	Yes
Year	1991
Vapor Pressure	3.8 kPa at 20 °C and 40 kPa at 62.1°C

Temperature	62.1 °C
Decomposition	No
Conclusion Remarks	The vapor pressure was 40.0 and 901.1 kPa at 62.1 and 154.3 °C, respectively. Calculated values of vapor pressure were 3.8 and 22.2 kPa at 20 and 50 °C, respectively.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from an acceptable standardized test method.
References	Hoechst AG (1991b) Unveroeffentlichte Untersuchung (S91/484).

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Technical grade
Method/guideline	Dynamic Method
GLP	Yes
Year	1990
Vapor Pressure	2.4 kPa
Temperature	20 °C
Decomposition	No
Conclusion Remarks	The vapor pressure was 40.0 and 901.1 kPa at 62.1 and 154.3 °C, respectively. Calculated values of vapor pressure were 3.8 and 22.2 kPa at 20 and 50 °C, respectively.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from an acceptable standardized test method.
References	Hoechst AG (1990) Sicherheitsdatenblatt Camphen (06.07.1990)

Substance Name	*alpha*-Pinene – Data for structurally related substance *delta*-3-Carene
CAS No.	80-56-8
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.35 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical structure.

References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Substance supported under SIDS.
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.24 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical structure.
References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.29 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical structure.
References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

Substance Name	Dihydropinene – Data for structurally related substance *cis*-Pinane
CAS No.	473-55-2
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.29 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical structure.
References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.55 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical structure.
References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.55 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical mixture.
References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% Dipenetene, 1-2% Camphene, 1-3% *beta*-Phellandrene, 0-2% Terpinolene
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.35 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical mixture.

References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.55 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical mixture.
References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Method/guideline	Mean of Antoine & Grain methods, calculated
Vapor Pressure	0.55 kPa
Temperature	25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR calculation and are consistent with chemical mixture.
References	Meylan W. (1994-1995c) MPBP, Syracuse Research Corporation.

1.4 n-Octanol/Water Partition Coefficient

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Sample consisted mainly of *alpha*-pinene with some camphene, *beta*-pinene and *delta*-3-carene. It was a 50/50 mixture from each of 2 suppliers.

Method/guideline	OECD Guideline 117
GLP	Yes
Year	1993
Log Pow	5.3, 5.5, 5.7
Temperature	35 °C
Conclusion Remarks	The data are for the three components in 3-carene at pH 7.5 with log Pow higher than 1.5. At pH 2.0, there were two components with log Kow of 5.3 and 5.6.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	No analytical data on identity of components presented.
References	Dybdahl, H.P. (1993a) Determination of log Pow for single components in *alpha*-pinene. Project 303068, Water Quality Institute, Horsholm, Denmark.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	Measured
Year	1995
Log Pow	4.83
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Data are from the Syracuse Research Corporation database.
References	Li J. and Perdue, E.M. (1995) Syracuse Research Corporation.

Substance Name	*alpha*-Pinene – Data for structurally related substance *delta*-3-Carene
CAS No.	80-56-8
Remarks for Substance	Test substance was 3-carene, which was reported by the authors to consist of *delta*-3-carene mixed with *alpha*-pinene, *beta*-pinene, and dipentene.
Method/guideline	OECD Guideline 117
GLP	Yes
Year	1993
Log Pow	4.6, 5.2, 5.3, 5.5
Temperature	35 °C
Conclusion Remarks	The data are for the four components in 3-carene at pH 7.5 with log Pow higher than 1.5. At pH 2.0, there were four components

	log Pow higher than 1.5. At pH 2.0, there were four components with log Kow of 4.5, 5.2, 5.3, and 5.5.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	No analytical data on identity of components presented.
References	Dybdahl H.P. (1993b) Determination of log Pow for single components in 3-carene. Project 303068, Water Quality Institute, Horsholm, Denmark.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	Kowwin calculation
Log Pow	4.27
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995a) LOGKOW, Syracuse Research Corporation.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	Kowwin calculation
Log Pow	4.35
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995a) LOGKOW, Syracuse Research Corporation.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Substance supported under SIDS.
Method/guideline	Kowwin calculation
Log Pow	4.35
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.

References	Meylan W. (1993-1995a) LOGKOW, Syracuse Research Corporation.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Method/guideline	Kowwin calculation
Log Pow	4.35
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995a) LOGKOW, Syracuse Research Corporation.

Substance Name	Dihydropinene
CAS No.	473-55-2
Method/guideline	Kowwin calculation
Log Pow	4.35
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995a) LOGKOW, Syracuse Research Corporation.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Method/guideline	Kowwin calculation
Log Pow	4.83
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995a) LOGKOW, Syracuse Research Corporation.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene.

Method/guideline	Kowwin calculation
Log Pow	4.83
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
References	Meylan W. (1993-1995a) LOGKOW, Syracuse Research Corporation.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Method/guideline	Kowwin calculation
Log Pow	4.35
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
References	Meylan W. (1993-1995a) LOGKOW, Syracuse Research Corporation.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Method/guideline	Kowwin calculation
Log Pow	4.83
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
References	Meylan W. (1993-1995a) LOGKOW, Syracuse Research Corporation.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Method/guideline	Kowwin calculation

Log Pow	4.83
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
References	Meylan W. (1993-1995a) LOGKOW, Syracuse Research Corporation.

1.5 Water Solubility

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	98% pure 1R(+)-isomer. Measured purity 91%
Method/guideline	Liquid-liquid equilibrium
GLP	No
Year	1990
Value (mg/L) at Temperature	0.65 mg/L at 25 °C
pH value and concentration at temperature	7.70
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study.
References	Broderius S., Hammermeister D.and Russom, C. (1990) Toxicity of eight terpenes to Fathead minnows (Pimephales promelas), Daphnids (Daphnia magna), and Algae (Selanastrum capricornutum), Unpublished report.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Remarks for Substance	99% pure 1S(-)-isomer. Measured purity 97%
Method/guideline	Liquid-liquid equilibrium
GLP	No
Year	1990
Value (mg/L) at Temperature	2.1 mg/L at 25 °C
pH value and concentration at temperature	7.6
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.

Remarks for Data Reliability	Comparable to guideline study.
References	Broderius S., Hammermeister D.and Russom, C. (1990) Toxicity of eight terpenes to Fathead minnows (Pimephales promelas), Daphnids (Daphnia magna), and Algae (Selanastrum capricornutum), Unpublished report.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Technical grade
Method/guideline	Determination of the solubility in water according to Method 84/449/EWG, Anhang V, and A.Teil.
Year	1991
Value (mg/L) at Temperature	4.2 mg/l at 20 °C
pH value and concentration at temperature	5.5 at 22 °C
Conclusion Remarks	The solubility of technical grade camphene in water at 20 °C is 4.2 mg/L. Camphene is considered to be insoluble in water at 20 °C.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained from an acceptable standardized test method.
References	Hoechst AG (1991c) Unveroeffentlichte Untersuchung, Analytisches Laboratorium. (Nr. 229-91(B))

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	WSKOW calculation
Value (mg/L) at Temperature	1.89 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995b) WSKOW, Syracuse Research Corporation.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	WSKOW calculation
Value (mg/L) at Temperature	4.89 mg/L at 25 °C

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995b) WSKOW, Syracuse Research Corporation.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Substance supported under SIDS.
Method/guideline	WSKOW calculation
Value (mg/L) at Temperature	3.52 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995b) WSKOW, Syracuse Research Corporation.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Method/guideline	WSKOW calculation
Value (mg/L) at Temperature	6.01 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995b) WSKOW, Syracuse Research Corporation.

Substance Name	Dihydropinene
CAS No.	473-55-2
Method/guideline	WSKOW calculation
Value (mg/L) at Temperature	4.73 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995b) WSKOW, Syracuse Research Corporation.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Method/guideline	WSKOW calculation
Remarks for Test Conditions	The data would be the same as for *alpha*-pinene.
Value (mg/L) at Temperature	1.89 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
References	Meylan W. (1993-1995b) WSKOW, Syracuse Research Corporation.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Method/guideline	WSKOW calculation
Remarks for Test Conditions	The data are considered to be essentially the same as for *alpha*-pinene.
Value (mg/L) at Temperature	0.65 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
References	Meylan W. (1993-1995b) WSKOW, Syracuse Research Corporation.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Method/guideline	WSKOW calculation
Remarks for Test Conditions	The data are considered to be essentially the same as for *beta*-pinene.
Value (mg/L) at Temperature	2.1 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
References	Meylan W. (1993-1995b) WSKOW, Syracuse Research Corporation.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Method/guideline	WSKOW calculation
Remarks for Test Conditions	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Value (mg/L) at Temperature	1.1 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
References	Meylan W. (1993-1995b) WSKOW, Syracuse Research Corporation.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Method/guideline	WSKOW calculation
Remarks for Test Conditions	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Value (mg/L) at Temperature	1.1 mg/L at 25 °C
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
References	Meylan W. (1993-1995b) WSKOW, Syracuse Research Corporation.

2 Environmental Fate and Pathways

2.1 Photodegradation

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	AOPWIN
Test Type	Calculated
Halflife t1/2	1.4 hrs
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are based upon measured OH, ozone and NO3 rate constants.
References	Meylan W. (1994-1995b) AOPWIN, Syracuse Research Corporation.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	AOPWIN
Test Type	Calculated
Halflife t1/2	2.2 hrs
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are based upon measured OH, ozone and NO3 rate constants.
References	Meylan W. (1994-1995b) AOPWIN, Syracuse Research Corporation.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Substance supported under SIDS.
Method/guideline	AOPWIN
Test Type	Calculated
Halflife t1/2	2.2 hrs
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.

Remarks for Data Reliability	The data are obtained by a recognized SAR method and are based upon measured OH, ozone and NO3 rate constants.
References	Meylan W. (1994-1995b) AOPWIN, Syracuse Research Corporation.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Method/guideline	AOPWIN
Test Type	Calculated
Halflife t1/2	9.4 hrs
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are based upon measured the OH rate constant for *trans*-pinane.
References	Meylan W. (1994-1995b) AOPWIN, Syracuse Research Corporation.

Substance Name	Dihydropinene
CAS No.	473-55-2
Method/guideline	AOPWIN
Test Type	Calculated
Halflife t1/2	9.4 hrs
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are based upon measured the OH rate constant for *trans*-pinane.
References	Meylan W. (1994-1995b) AOPWIN, Syracuse Research Corporation.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Method/guideline	AOPWIN
Test Type	Calculated
Halflife t1/2	1.4 hrs
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are based upon measured OH, ozone and NO3 rate constants.
References	Meylan W. (1994-1995b) AOPWIN, Syracuse Research Corporation.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Method/guideline	AOPWIN
Test Type	Calculated
Halflife t1/2	1.4 hrs
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are based upon measured OH, ozone and NO3 rate constants.
References	Meylan W. (1994-1995b) AOPWIN, Syracuse Research Corporation.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Method/guideline	AOPWIN
Test Type	Calculated
Halflife t1/2	2.2 hrs
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are based upon measured OH, ozone and NO3 rate constants.
References	Meylan W. (1994-1995b) AOPWIN, Syracuse Research Corporation.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Method/guideline	AOPWIN
Test Type	Calculated
Halflife t1/2	1.7 hrs
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.

Remarks for Data Reliability	The data are obtained by a recognized SAR method and are based upon measured OH, ozone and NO3 rate constants.
References	Meylan W. (1994-1995b) AOPWIN, Syracuse Research Corporation.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Method/guideline	AOPWIN
Test Type	Calculated
Halflife t1/2	1.7 hrs
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are based upon measured OH, ozone and NO3 rate constants.
References	Meylan W. (1994-1995b) AOPWIN, Syracuse Research Corporation.

2.2 Biodegradation

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	> 99% pure
Test Type	Closed Bottle Test
GLP	No
Year	1996
Contact Time	30 days
Innoculum	Soil extracts prepared from samples collected from coniferous (A) and mixed hardwood forest (B) watersheds.
Remarks for Test Conditions	Sealed flasks containing oxygen-saturated media were preconditioned with concentration of 0.5-3.0 mg/L of *alpha*-pinene for 24 hours. Soil extracts A or B were added and the solution was stirred for 30 days in the dark at 23 °C. At regular intervals samples were removed and analyzed for terpene and CO2. In a second experiment, O2-saturated minimum media and hydrocarbon were incubated with innoculum withdrawn from the terpene-fed reactor used in the previous experiment. These solutions were incubated as listed above. Azide-amended solutions were used as controls.

Degradation % After Time	100% at 170 hours
Results	Compared to azide-amended controls, *alpha*-pinene was completely biodegraded in unacclimated and acclimated soil A and B extracts within 30 days. In unacclimated and acclimated soil A extract, lag times of 200 and 98 hours, respectively were recorded.
Kinetic	Maximum degradation rate = 0.039 mg/L x hr (unacclimated) or 0.63 mg/L x hr (acclimated)
10 day Window Criteria	Yes
Total degradation	100% within 170 hours
Classification	Completely biodegradable
Remarks Results	Degradation of pinene was not measurable in azide-treated innoculum, thus the activity of the innoculum was verified and the test was considered valid. *alpha*-Pinene did not exhibit any toxic effects to the microorganisms at the concentration tested.
Conclusion Remarks	The test substance, *alpha*-pinene, underwent 100% biodegradation after approximately 7 days under the test conditions. Biodegradation in unacclimated medium started on day 8 and reached 100% at the end of the day 15. In acclimated soil extract, 100 % degradation occurred within 8 days. The authors concluded the pinene is completely degradable in extracts prepared from watershed soils of coniferous or deciduous forests.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The experiments did not comply with standardized test guidelines. They were part of a comprehensive study of the biodegradation of pinene in forest soil regimens. The experimental techniques and methods of analysis were exhaustive.
Reference	Misra G., Pavlostathis S. G., Perdue E. M., and Araujo R. (1996) Aerobic biodegradation of selected monoterpenes. Applied Microbiology and Biotechnology, 45, 831-838.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	98.6% pure by GC; almost colorless liquid; density 0.858 g/ml at 20 °C
Method/guideline	OECD Guideline 301F
Test Type	Manometric Respirometry Test
GLP	Yes
Year	1998
Contact Time	28 days
Innoculum	Activated sludge, fresh

Remarks for Test Conditions	Followed OECD Guideline 301F. The reference substance used was sodium benzoate. The concentration of test substance used was 100 mg/l and the test temperature was 22 °C.
Degradation % After Time	38% degradation after 28 days
Results	The % degradation (mean of 2 identical flasks) after 3 days is 17%; 5 days is 23%; 7 days is 26%; 13 days is 34%; 21 days is 36% and 28 days is 38%.
10 day Window Criteria	34% at the end of the 10 day window (days 3-13)
Total degradation	38% after 28 days
Classification	Not readily biodegradable
Remarks Results	Averages of 2 identical flasks were used to determine the results. Degradation of sodium benzoate exceeded 40% after 7 days and 65% after 14 days, thus the activity of the innoculum was verified and the test was considered valid. *alpha*-Pinene did not exhibit any toxic effects to the micro-organisms at the concentration tested.
Conclusion Remarks	The test substance, *alpha*-pinene, underwent 38% biodegradation after 28 days under the test conditions. Biodegradation started on day 3 and reached only 34% at the end of the 10-day window. The authors commented that although the test was generally recognized as being applicable to volatile substances, the rather high vapor pressure and low water solubility might have created a loss of test substance in the test medium, which resulted in low results. The authors of the test did not consider the test definitive.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	GLP study conducted according to OECD guidelines.
Reference	Rudio J. (1999b) Ready biodegradability of pinene *alpha* according to OECD Guideline 301F. Private communication to FFHPVC.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	98.6% pure by GC; almost colorless liquid; density 0.858 g/ml at 20 °C
Method/guideline	OECD Guideline 302C
Test Type	Manometric Respirometry Test
GLP	Yes
Year	1999
Contact Time	31 days
Innoculum	Activated sludge, fresh

Remarks for Test Conditions	Followed OECD Guideline 302C. The reference substance used was sodium benzoate. The concentration of test substance used was 30 mg/l. The test temperature was 25 °C.
Degradation % After Time	37% degradation after 31 days
Results	The % degradation (mean of 2 identical flasks) after 5 days is 9%; 7 days is 12%; 14 days is 34%; 21 days is 35%; 28 days is 37% and 31 days is 37%.
Time required for 10% degradation	5-7 days
Total degradation	37% after 31 days
Classification	Not inherently but partially biodegradable
Remarks Results	Averages of 2 identical flasks were used to determine the results. Degradation of sodium benzoate was 68% after 7 days and 94% after 14 days, which exceeded the validity criterion, thus the activity of the innoculum was verified and the test was considered valid.
Conclusion Remarks	The test substance, *alpha*-pinene, underwent 37% biodegradation after 31 days under the test conditions. The authors commented that the low biodegradation percentage may be attributed to the high vapor pressure and low water solubility of the substance leading to volatilization of the test substance in the upper parts of the test vessel.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	GLP study conducted according to OECD guidelines.
Reference	Rudio J. (1999a) Inherent biodegradability of pinene *alpha* according to OECD Guideline 302C. Private communication.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Test substance reported to have consisted mainly of *alpha*-pinene mixed with camphene, *beta*-pinene and *delta*-3-carene
Method/guideline	OECD Guideline 301D
Test Type	Closed Bottle Test
GLP	Yes
Year	1981
Contact Time	7, 14, 21, 28 days
Innoculum	Secondary effluent
Remarks for Test Conditions	The test medium was initially aerated to an oxygen concentration of 9 mg oxygen/L and inoculated with 1 drop of secondary effluent per liter. The test product was added at 2.5 mg/L to a part of the inoculated test medium, equivalent to a chemical oxygen demand of 5.97 mg oxygen/L. A reference compound was used. Test product and reference compound

	were added to the inoculated medium to evaluate any inhibitory effects. Blank controls were also used. After all additions, the medium was transferred to calibrated respirometric bottles (BOD bottles). The test bottles were kept in the dark at a constant temperature of 20 °C. Triplicate sets of test bottles were sacrificed at the start of the experiment and after 7, 14, 21, and 28 days for oxygen measurements. The oxygen demand was calculated as the difference between measured oxygen concentrations at time t and at the start of the test. The biological oxygen demand for the added carbon sources was calculated by subtracting the oxygen demand in the blank controls from the oxygen demand in the bottles containing the test and reference compounds.
Degradation % After Time	Mean percentage values: 7 days-3.1; 14 days-3.1; 21 days-5.7; 28 days-2.2
Results	The test medium was initially aerated to an oxygen concentration of 9 mg oxygen/L and inoculated with 1 drop of secondary effluent per liter. The test product was added at 2.5 mg/L to a part of the inoculated test medium, equivalent to a chemical oxygen demand of 5.97 mg oxygen/L. A reference compound was used. Test product and reference compound were added to the inoculated medium to evaluate any inhibitory effects. Blank controls were also used. After all additions, the medium was transferred to calibrated respirometric bottles (BOD bottles). The test bottles were kept in the dark at a constant temperature of 20 °C. Triplicate sets of test bottles was sacrificed at the start of the experiment and after 7, 14, 21, and 28 days for oxygen measurements. The oxygen demand was calculated as the difference between measured oxygen concentrations at time t and at the start of the test. The biological oxygen demand for the added carbon sources was calculated by subtracting the oxygen demand in the blank controls from the oxygen demand in the bottles containing the test and reference compounds.
Remarks Results	The biological oxygen demand for *alpha*-pinene was 3.1% and 2.2% of the theoretical oxygen demand after 7 and 28 days respectively. No inhibitory effects of *alpha*-pinene were observed.
Conclusion Remarks	Not readily biodegradable
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	GLP study conducted according to OECD guidelines.
Reference	Madsen T. (1993a) Biodegradation of *alpha*-pinene. Project 303068, Water Quality Institute, Horsholm, Denmark.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	> 99% pure
Method/guideline	Closed Bottle Test

GLP	No
Year	1996
Contact Time	30 days
Innoculum	Soil slurries prepared from samples collected from coniferous (A) and mixed hardwood forest (B) watersheds.
Remarks for Test Conditions	Sealed flasks containing of soil slurry deactivated by autoclave heating were treated with sodium azide and a mixture of 4 hydrocarbons including *alpha*-pinene in the dark at 23 C. At regular intervals the solutions were extracted with isooctane and analyzed for terpene. Subsequently, O2-saturated minimum media and hydrocarbon (0.6 mg/tube) were incubated with a 20% soil slurry. CO2 and terpene concentrations were measured by gas chromatography.
Degradation % After Time	100% within 120 hours
Results	Compared to azide-amended controls, *alpha*-pinene was completely biodegraded by soil slurries A or B extracts within 6 days. The maximum rate of biodegradation 3.3 mg/L x hr tested as a mixture and 5.2 mg/L x hr for pinene itself.
Kinetic	Maximum degradation rate = 5.2 mg/L x hr
Time required for 10% degradation	< 20 hours
10 day Window Criteria	Yes
Total degradation	100% within 120 hours
Classification	Completely biodegradable
Remarks Results	Degradation of pinene was not measurable in azide-treated innoculum, thus the activity of the soil slurry was verified and the test was considered valid.
Conclusion Remarks	The test substance, *alpha*-pinene, underwent 100% biodegradation after approximately 6 days under the test conditions. The authors concluded the pinene is completely degradable in extracts prepared from watershed soils of coniferous or deciduous forests.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The experiments did not comply with standardized test guidelines. They were part of a comprehensive study of the biodegradation of pinene in forest soil regimens. The experimental techniques and methods of analysis were exhaustive.
Reference	Misra G., Pavlostathis, S. G., Perdue, E. M., and Araujo, R. (1996) Aerobic biodegradation of selected monoterpenes. Applied Microbiology and Biotechnology, 45, 831-838.

Substance Name	*alpha*-Pinene – Data for structurally related substance *delta*-3-Carene
CAS No.	80-56-8

Remarks for Substance	Test substance was 3-carene which was reported to consist mainly of *delta*-3-carene mixed with *alpha*-pinene, *beta*-pinene and dipentene
Method/guideline	OECD Guideline 301D
Test Type	Closed Bottle Test
GLP	Yes
Year	1981
Contact Time	7, 14, 21, 28 days
Innoculum	Secondary effluent
Remarks for Test Conditions	The test medium was initially aerated to an oxygen concentration of 9 mg oxygen/L and inoculated with 1 drop of secondary effluent per liter. The test product was added at 7.8 mg/L to a part of the inoculated test medium, equivalent to a chemical oxygen demand of 4.80 mg oxygen/L. A reference compound was used. Test product and reference compound were added to the inoculated medium to evaluate any inhibitory effects. Blank controls were also used. After all additions, the medium was transferred to calibrated respirometric bottles (BOD bottles). The test bottles were kept in the dark at a constant temperature of 20 °C. Triplicate sets of test bottles were sacrificed at the start of the experiment and after 7, 14, 21, and 28 days for oxygen measurements. The oxygen demand was calculated as the difference between measured oxygen concentrations at time t and at the start of the test. The biological oxygen demand for the added carbon sources was calculated by subtracting the oxygen demand in the blank controls from the oxygen demand in the bottles containing the test and reference compounds.
Degradation % After Time	Mean values:7 days- 6.3; 14 days- 17.4; 21 days-1.3; 28 days-3
Results	The reference compound, sodium benzoate, was more than 60% degraded within the first seven days of the test period and thus was considered to have satisfactory activity.
Remarks Results	The biological oxygen demand for 3-carene was 6.3% and 3.8% of the theoretical oxygen demand after 7 and 28 days, respectively. The higher oxygen consumption observed in two replicates at day 14 was attributed by the authors to an inhomogeneous partition of product or a result of biological variation in the test bottles. No inhibitory effects of 3-carene were observed.
Conclusion Remarks	Not readily biodegradable
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	GLP study conducted according to OECD guidelines.
Reference	Madsen T. (1993b) Biodegradation of 3-carene. Project 303068, Water Quality Institute, Horsholm, Denmark.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Technical grade
Method/guideline	DIN 38409, part 52, Guideline 79/1831/EEC©
Test Type	Aerobic
GLP	Yes
Year	1988
Innoculum	Activated sludge, domestic
Total degradation	< 20 % after 28 day(s)
Conclusion Remarks	The test substance, camphene, underwent 20% biodegradation after 28 days under the test conditions. The low biodegradation percentage may be attributed to the high vapor pressure and low water solubility of the substance leading to volatilization of the test substance in the upper parts of the test vessel.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	GLP study conducted according to OECD guidelines.
Reference	Hoechst AG (1988a) Unveroeffentlichte Untersuchung (V 88.0514).

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Test substance was composed of 50.9% *alpha*-pinene and 36.8% beta-pinene
Method/guideline	Modified EU CO2 evolution test and OECD 301B Guideline
Test Type	28-day ready biodegradability test
GLP	Yes
Year	2001
Contact time (units)	28 days
Innoculum	Secondary effluent obtained from laboratory rolling tube unit fed by 100% settled sewage from Newton Abbot sewage treatment works
10 day window criteria	No
Time required for 10% degradation	3 days
Degradation % after time	52% after 28 days
Results	The reference substance, aniline underwent 78% biodegradation after 28 days. The test substance, gum

	turpentine, was 13% biodegraded after 4 days, 37% after 7 days, and 52% after 28 days.
Remarks for Test Conditions	Sealed bottles containing 95 ml of inoculated medium (OECD 301B), 2.27 mg test substance, 5 ml deionized water were incubated for 28 days at 20.0 C while being shaken at 150 rpm. The reference material (aniline) was used at a test concentration of 20 mg/L. Blank controls were also used. Experiments were performed in triplicate. At 4,7, 14, 20, and 28 days, inorganic carbon (carbon dioxide) was analyzed.
Conclusion Remarks	Gum turpentine was considered to be inherently biodegradable in that the test substance did not reach a plateau of biodegradation at day 28
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	GLP study conducted according to OECD guidelines.
Reference	Long K. W. J. (2001b) Gum turpentine: Determination of 28-day ready biodegradability (Closed Bottle Sturm Test). Report No. BI7034/B. Unpublished report.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	BIOWIN
Test Type	Calculated
Results	Probability of rapid biodegradation - linear model 0.50 - nonlinear 0.34. Expert survey results - ultimate, weeks to months; primary, days to weeks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are from a recognized SAR calculation and are consistent with chemical structure.
Reference	Meylan W. (1994a) BIOWIN, Syracuse Research Corporation.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	BIOWIN
Test Type	Calculated
Results	Probability of rapid biodegradation - linear model 0.50 - nonlinear 0.34. Expert survey results - ultimate, weeks to months; primary, days to weeks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are from a recognized SAR calculation and are consistent with chemical structure.
Reference	Meylan W. (1994a) BIOWIN, Syracuse Research Corporation.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	BIOWIN
Test Type	Calculated
Results	Probability of rapid biodegradation - linear model 0.50 - nonlinear 0.34. Expert survey results - ultimate, weeks to months; primary, days to weeks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are from a recognized SAR calculation and are consistent with chemical structure.
Reference	Meylan W. (1994a) BIOWIN, Syracuse Research Corporation.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Method/guideline	BIOWIN
Test Type	Calculated
Results	Probability of rapid biodegradation - linear model 0.50 - nonlinear 0.34. Expert survey results - ultimate, weeks to months; primary, days to weeks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are from a recognized SAR calculation and are consistent with chemical structure.
Reference	Meylan W. (1994a) BIOWIN, Syracuse Research Corporation.

Substance Name	Dihydropinene
CAS No.	473-55-2
Method/guideline	BIOWIN
Test Type	Calculated
Results	Probability of rapid biodegradation - linear model 0.50 - nonlinear 0.34. Expert survey results - ultimate, weeks to months; primary, days to weeks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are from a recognized SAR calculation and are consistent with chemical structure.
Reference	Meylan W. (1994a) BIOWIN, Syracuse Research Corporation.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Method/guideline	BIOWIN
Test Type	Calculated
Results	Probability of rapid biodegradation - linear model 0.50 - nonlinear 0.34. Expert survey results - ultimate, weeks to months; primary, days to weeks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are from a recognized SAR calculation and are consistent with chemical structure.
Reference	Meylan W. (1994a) BIOWIN, Syracuse Research Corporation.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Method/guideline	BIOWIN
Test Type	Calculated
Remarks for Test Conditions	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Results	Probability of rapid biodegradation - linear model 0.50 - nonlinear 0.34. Expert survey results - ultimate, weeks to months; primary, days to weeks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are from a recognized SAR calculation and are consistent with chemical mixture.
Reference	Meylan W. (1994a) BIOWIN, Syracuse Research Corporation.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Method/guideline	BIOWIN
Test Type	Calculated
Remarks for Test Conditions	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.

Results	Probability of rapid biodegradation - linear model 0.50 - nonlinear 0.34. Expert survey results - ultimate, weeks to months; primary, days to weeks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are from a recognized SAR calculation and are consistent with chemical mixture.
Reference	Meylan W. (1994a) BIOWIN, Syracuse Research Corporation.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.).
Method/guideline	BIOWIN
Test Type	Calculated
Remarks for Test Conditions	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Results	Probability of rapid biodegradation - linear model 0.50 - nonlinear 0.34. Expert survey results - ultimate, weeks to months; primary, days to weeks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are from a recognized SAR calculation and are consistent with chemical mixture.
Reference	Meylan W. (1994a) BIOWIN, Syracuse Research Corporation.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Method/guideline	BIOWIN
Test Type	Calculated
Remarks for Test Conditions	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Results	Probability of rapid biodegradation - linear model 0.50 - nonlinear 0.34. Expert survey results - ultimate, weeks to months; primary, days to weeks.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are from a recognized SAR calculation and are consistent with chemical mixture.
Reference	Meylan W. (1994a) BIOWIN, Syracuse Research Corporation.

2.3 Fugacity

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Sediment
Estimated Distribution and Media Concentration	.019%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Air-Water Partition Coefficient
Absorption coefficient	13.97
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or

	metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Aerosol
Estimated Distribution and Media Concentration	.000019%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Suspended Sediment
Estimated Distribution and Media Concentration	.00059%

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Soil
Estimated Distribution and Media Concentration	0.85%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP

Media	Water
Estimated Distribution and Media Concentration	.014%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Air
Estimated Distribution and Media Concentration	99.12%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay

Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	9479
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Fish-Water Partition Coefficient
Absorption coefficient	3380
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	8316
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Sediment-Water Partition Coefficient
Absorption coefficient	2661
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene

CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Soil-Water Partition Coefficient
Absorption coefficient	1330
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Fish
Estimated Distribution and Media Concentration	.000048%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Sediment-Water Partition Coefficient
Absorption coefficient	881
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Water
Estimated Distribution and Media Concentration	0.03%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.

References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Aerosol
Estimated Distribution and Media Concentration	0.00002%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Fish
Estimated Distribution and Media Concentration	0.00003%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.

Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.0004%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Sediment

Estimated Distribution and Media Concentration	0.01%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Soil
Estimated Distribution and Media Concentration	0.53%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I

Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Air
Estimated Distribution and Media Concentration	99.4%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	9080
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	2750
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Soil-Water Partition Coefficient
Absorption coefficient	441
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3

Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Air-Water Partition Coefficient
Absorption coefficient	7.43
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, water solubility, estimated MP, log Kow
Media	Fish-Water Partition Coefficient
Absorption coefficient	1120
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Soil
Estimated Distribution and Media Concentration	0.53%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	5020
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental

	models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Aerosol
Estimated Distribution and Media Concentration	0.00001%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Fish
Estimated Distribution and Media Concentration	0.00003%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or

	metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.0004%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Sediment
Estimated Distribution and Media Concentration	0.01%

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Air-Water Partition Coefficient
Absorption coefficient	7.43
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility

Media	Fish-Water Partition Coefficient
Absorption coefficient	1120
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	2750
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay

Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Sediment-Water Partition Coefficient
Absorption coefficient	881
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Soil-Water Partition Coefficient
Absorption coefficient	441
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Water
Estimated Distribution and Media Concentration	0.03%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Camphene
CAS No.	79-92-5
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Air
Estimated Distribution and Media Concentration	99.4%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane

CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Soil
Estimated Distribution and Media Concentration	0.49%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Aerosol
Estimated Distribution and Media Concentration	0.00002%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Fish
Estimated Distribution and Media Concentration	0.00003%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Sediment
Estimated Distribution and Media Concentration	0.01%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.

References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Water
Estimated Distribution and Media Concentration	0.02%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Air
Estimated Distribution and Media Concentration	99.5%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.

Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Fish-Water Partition Coefficient
Absorption coefficient	1120
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Suspended Sediment-Water Partition Coefficient

Absorption coefficient	2750
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Sediment-Water Partition Coefficient
Absorption coefficient	881
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I

Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Soil-Water Partition Coefficient
Absorption coefficient	441
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Air-Water Partition Coefficient
Absorption coefficient	8.11
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	8720
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.0003%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2

Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Sediment-Water Partition Coefficient
Absorption coefficient	881
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Fish
Estimated Distribution and Media Concentration	0.00003%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.0003%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Sediment
Estimated Distribution and Media Concentration	0.01%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental

	models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Soil
Estimated Distribution and Media Concentration	0.49%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Water
Estimated Distribution and Media Concentration	0.02%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or

	metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Air
Estimated Distribution and Media Concentration	99.5%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	8720

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	2750
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility

Media	Soil-Water Partition Coefficient
Absorption coefficient	441
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Air-Water Partition Coefficient
Absorption coefficient	8.11
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay

Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Aerosol
Estimated Distribution and Media Concentration	0.00002%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Dihydropinene
CAS No.	473-55-2
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, estimated VP, log Kow, MP, water solubility
Media	Fish-Water Partition Coefficient
Absorption coefficient	1120
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press. Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Sediment
Estimated Distribution and Media Concentration	.019%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Air-Water Partition Coefficient
Absorption coefficient	13.97
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental

	models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Aerosol
Estimated Distribution and Media Concentration	.000019%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Suspended Sediment
Estimated Distribution and Media Concentration	.00059%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or

	metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Soil
Estimated Distribution and Media Concentration	0.85%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Water
Estimated Distribution and Media Concentration	.014%

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Air
Estimated Distribution and Media Concentration	99.12%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP

Media	Aerosol-Air Partition Coefficient
Absorption coefficient	9479
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Fish-Water Partition Coefficient
Absorption coefficient	3380
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay

Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	8316
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Sediment-Water Partition Coefficient
Absorption coefficient	2661
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Soil-Water Partition Coefficient
Absorption coefficient	1330
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	MW, VP, log Kow, water solubility, estimated MP
Media	Fish
Estimated Distribution and Media Concentration	.000048%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene

CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Sediment
Absorption coefficient	2661
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Water
Estimated Distribution and Media Concentration	.014%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.

References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Aerosol
Estimated Distribution and Media Concentration	.000019%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Fish

Estimated Distribution and Media Concentration	.000048%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Suspended Sediment
Estimated Distribution and Media Concentration	.00059%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Sediment
Estimated Distribution and Media Concentration	.019%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Soil
Estimated Distribution and Media Concentration	0.85%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene

CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Air
Estimated Distribution and Media Concentration	99.12%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	9479
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.

References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	8316
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Soil-Water Partition Coefficient

Absorption coefficient	1330
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Air-Water Partition Coefficient
Absorption coefficient	13.97
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *alpha*-Pinene
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*-pinene.
Media	Fish-Water Partition Coefficient
Absorption coefficient	3380
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	9080
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Aerosol
Estimated Distribution and Media Concentration	0.00002%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Fish
Estimated Distribution and Media Concentration	0.00003%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.

Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.0004%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay

Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Sediment
Estimated Distribution and Media Concentration	0.01%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Soil
Estimated Distribution and Media Concentration	0.53%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene

CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Fish-Water Partition Coefficient
Absorption coefficient	1120
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	2750
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or

	metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Sediment-Water Partition Coefficient
Absorption coefficient	881
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I

Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Soil-Water Partition Coefficient
Absorption coefficient	441
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Air-Water Partition Coefficient
Absorption coefficient	7.43
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6

Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Water
Estimated Distribution and Media Concentration	0.03%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Terpenes, Terpenoids, Turpentine oil, *beta*-Pinene
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *beta*-pinene.
Media	Air
Estimated Distribution and Media Concentration	99.4%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.

References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Sediment
Estimated Distribution and Media Concentration	0.02%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Soil-Water Partition Coefficient

Absorption coefficient	1060
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Sediment-Water Partition Coefficient
Absorption coefficient	2100
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	6600
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Fish-Water Partition Coefficient
Absorption coefficient	2700
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum

CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	9400
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Air
Estimated Distribution and Media Concentration	99%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.

References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Air-Water Partition Coefficient
Absorption coefficient	12
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Soil

Estimated Distribution and Media Concentration	0.8%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.0005%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model

Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Fish
Estimated Distribution and Media Concentration	0.00004%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Aerosol
Estimated Distribution and Media Concentration	0.00002%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine gum

CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.)
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Water
Estimated Distribution and Media Concentration	0.02%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Soil
Estimated Distribution and Media Concentration	0.8%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or

	metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Aerosol
Estimated Distribution and Media Concentration	0.00002%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay

Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Fish
Estimated Distribution and Media Concentration	0.00004%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Sediment
Estimated Distribution and Media Concentration	0.02%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Water
Estimated Distribution and Media Concentration	0.02%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Air
Estimated Distribution and Media Concentration	99%

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Aerosol-Air Partition Coefficient
Absorption coefficient	9400
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.

Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Fish-Water Partition Coefficient
Absorption coefficient	2700
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Suspended Sediment-Water Partition Coefficient
Absorption coefficient	6600
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Sediment-Water Partition Coefficient
Absorption coefficient	2100
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Soil-Water Partition Coefficient

Absorption coefficient	1060
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Air-Water Partition Coefficient
Absorption coefficient	12
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole

Model Conditions	25 C, 100,000 lbs.
Test Type	Environmental Equilibrium Partitioning Model
Method	Mackay
Model Used	EQC V 2.11 Level I
Input Parameters	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Media	Suspended Sediment
Estimated Distribution and Media Concentration	0.0005%
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized fugacity calculation method. Data are considered reliable with restriction because this method does not allow for biodegradation or metabolism.
References	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publishing, CRC Press, Boca Raton, FL.

3 Ecotoxicity

3.1 Acute Toxicity to Fish

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Sample consisted mainly of *alpha*-pinene with remainder being camphene, *beta*-pinene and *delta*-3-carene. It was a 50/50 mixture from each of 2 suppliers.
Method/guideline	OECD Guideline 203
Test Type	Fish acute - semistatic
GLP	Yes
Year	1993
Species/Strain/Supplier	*Brachydanio rerio* from "local supplier"
Analytical monitoring	None
Exposure Period	0, 24, 48, 72, 96 hours
Remarks for Test Conditions	Semistatic - water changed every 24 hours. Stock solution prepared by ultrasonication of 5000 mg/L mixture.
Observations on precipitation	Behavioral & lethality
Nominal concentrations as mg/L	10, 20, 50, 100, 200, 500
Reference substances	K2Cr2O7
Remarks fields for results	No effects at 20 mg/L until 100% mortality at 96 hours.
Conclusion Remarks	LC50 = 200-500 mg/L (48 hr); 100-200 mg/L (72 hr); 10-20 mg/L (96 hr)
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	The abrupt lethality at low doses with no clinical signs is suspect. All test levels reported are above water solubility. No analyses for concentrations or for composition.
Reference	Bjornestad E. (1993a) Fish acute toxicity test of *alpha*-pinene with zebrafish. Project 303068, Water Quality Institute, Horsholm, Denmark.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	98% pure 1R(+)-isomer. Measured purity 91%.

Method/guideline	US EPA
Test Type	Fish acute - semistatic
GLP	No
Year	1990
Species/Strain/Supplier	Fathead minnows (Pimephales promelas)
Analytical monitoring	0, 24, 48, 72, 96 hrs
Exposure Period	96 hr
Remarks for Test Conditions	Sterilized, filtered water from Lake Superior. Changed every 24 hrs. Observations were loss of equilibrium and mortality.
Observations on precipitation	Behavioral & lethality
Nominal concentrations as mg/L	0.13,0.26,0.39,0.52,0.65
Measured concentrations as mg/L	0.058, 0.14, 0.23, 0.30, 0.42
Reference substances	Behavioral & lethality effects first seen at 24 hours.
Conclusion Remarks	EC50 = 0.18 mg/L (96hr); LC50 = 0.28 mg/L (96hr)
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained by a recognized method and are consistent with chemical structure. Data are considered reliable.
Reference	Broderius S., Hammermeister D.and Russom, C. (1990) Toxicity of eight terpenes to Fathead minnows (Pimephales promelas), Daphnids (Daphnia magna), and Algae (Selanastrum capricornutum), Unpublished report.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Remarks for Substance	99% pure 1S(-)-isomer. Measured purity 97%
Method/guideline	US EPA
Test Type	Fish acute - semistatic
GLP	No
Year	1990
Species/Strain/Supplier	Fathead minnows (Pimephales promelas)
Analytical monitoring	0, 24, 48, 72, 96 hrs.
Exposure Period	96 hr

Remarks for Test Conditions	Sterilized, filtered water from Lake Superior. Changed every 24 hours. Observations were loss of equilibrium and mortality.
Observations on precipitation	Behavioral & lethality
Nominal concentrations as mg/L	0.42,0.84,1.3,1.7, 2.1
Measured concentrations as mg/L	0.24, 0.58, 1.0, 1.2, 1.8
Remarks fields for results	Behavioral & lethality effects first seen at 24 hour.
Conclusion Remarks	EC50 = 0.50 mg/L (96 hr); LC50 = 0.50 mg/L (96 hrs)
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained by a recognized method and are consistent with chemical structure and are considered reliable.
Reference	Broderius S., Hammermeister, D.and Russom, C. (1990) Toxicity of eight terpenes to Fathead minnows (Pimephales promelas), Daphnids (Daphnia magna), and Algae (Selanastrum capricornutum), Unpublished report.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Camphene minimum 80 %
Method/guideline	OECD Guideline 203
Test Type	Static
Species/Strain/Supplier	*Cyprinodon variegatus* (Fish, estuary, marine)
Exposure Period	96 hr
Remarks for Test Conditions	Because of limited solubility, camphene was dissolved in acetone and triethylene glycol for use in the static test.
Measured concentrations as mg/L	LC50 <1.8 mg/L at 24 hours, <2 mg/L at 48 hours, <2 hr mg/L at 72 hours, and <0.19 mg/L at 96 hours
Remarks fields for results	The static test was performed with natural seawater according to the test protocol, "Methods for acute toxicity tests with fish, macroinvertebrates and amphibians", US EPA, 1975.
Conclusion Remarks	LC50 = 1.9 mg/L
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	The results of the test are not reliable for extrapolation to fish acute toxicity under environmental conditions.
Reference	McGowan and Mellors (1986) Bull. Environ. Contam. Toxicol., 36(6), 881-887 and Heitmueller, Hollister, and Parrish (1981) Bull. Environ. Contam. Toxicol., 27(5), 596-604.

Substance Name	Camphene
CAS No.	79-92-5

Remarks for Substance	Substance is 86.7 % camphene
Method/guideline	OECD Guideline 203
Test Type	Flow-through
GLP	Yes
Year	1993
Species/Strain/Supplier	*Brachydanio rerio* (Fish, fresh water)
Exposure Period	96 hr
Remarks for Test Conditions	Due to the high vapor pressure and limited solubility of the test substance, experiments were performed in a closed flow through system.
Measured concentrations as mg/L	LC50 =1.40 mg/L at 24 hours, 1.21 mg/L at 48 hours, 0.94 mg/L at 72 hours, and 0.72 mg/L at 96 hours
Conclusion Remarks	LC50 = 0.72 mg/L.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Reference	Hoechst AG (1993) Dr. Noack (92.1127). Unpublished report.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Technical grade
Method/guideline	OECD Guideline 203
Test Type	Static
GLP	Yes
Year	1988
Species/Strain/Supplier	*Brachydanio rerio* (Fish, fresh water)
Exposure Period	96 hr
Remarks for Test Conditions	Because of limited solubility, camphene was dissolved in ethanol for use in the static test.
Measured concentrations as mg/L	LC50 = 125 mg/L, LC50 = 150 mg/L, LC100 = 180 mg/L
Conclusion Remarks	LC50 = 150 mg/L
Data Qualities Reliabilities	Reliability code 3. Not reliable
Remarks for Data Reliability	The results of the test are not reliable for extrapolation to fish acute toxicity under environmental conditions.
Reference	Hoechst AG (1988b) Unveroeffentlichte Untersuchung (88.0254). Unpublished report.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Turpentine gum a mixture of 50.8% alpha-pinene and 36.9% beta-pinene
Method/guideline	Static fish acute toxicity/OECD guideline 203
Test Type	96-hr acute fish toxicity test
GLP	Yes
Year	2000
Species/Strain/Supplier	Rainbow Trout (Oncorhynchus mykiss)/West Country Trout/Trafalgar Farm
Exposure Period	96 hrs
Remarks for Test Conditions	Groups of ten fish acclimatized for 7days at 15 C were exposed to nominal concentrations of 0, 1.0, 10.0 and 100 mg/L of gum turpentine for 96 hours at 15 C. Solutions of gum turpentine were water accommodated fractions prepared by stirring appropriate weight of test substance for 23 hours followed by 1 hour settling time prior to fish being introduced. Dilution water was dechlorinated tap water that was filtered, sterilized and refiltered (10 um). pH, conductivity dissolved oxygen, and free and residual chlorine were monitored daily and alkalinity and total ammonia were measured at the beginning of the study. Fish were exposed to 16 hours fluorescent light and 8 hours darkness. Fish were monitored for mortality and toxicity at 2, 24, 48, 72, and 96 hours.At end of exposure fish were weighed and measured.
Nominal concentrations as mg/L	1.0 10. And 100 mg/L
Remarks for Results	There were no symptoms of toxicity and no mortalities at concentrations up to and including 100 mg/L. During test, pH values were in the range from 7.67 to 7.90 and dissolved oxygen was 9.02 to 9.74 mg/L at 15+/-1 C.
Conclusion Remarks	The 96-hour no observable effect concentration (NOEC)=100 mg/L
Remarks for Data Reliability	The data are obtained by an OECD guideline method and are consistent with chemical structure. Data are considered reliable.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Reference	Swarbrick R.H. (2001) Gum turpentine: Acute toxicity to rainbow trout (Oncorhynchus mykiss). BL7033/B. Unpublished Report.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8

Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.22 mg/l
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.62 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure. Data are considered reliable.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Substance supported under SIDS.
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.62 mg/l
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.

Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure. Data are considered reliable.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.63 mg/l
Remarks for Data Reliability	Reliability code 2. Reliable with restrictions.
Data Reliability Remarks	The data are obtained by a recognized SAR method and are consistent with chemical structure. Data are considered reliable.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Dihydropinene
CAS No.	473-55-2
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.63 mg/l
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure. Data are considered reliable.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4

Remarks for Substance	Data considered the same as for the isomer *alpha*-pinene
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.28 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure. Data are considered reliable.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure Period	96 hr
Remarks for Test Conditions	The input data are considered to be essentially the same as for *alpha*-pinene.
Conclusion Remarks	LC50 = 0.28 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Data Reliability Remarks	The data are obtained by a recognized SAR method and are consistent with chemical composition of the mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta* phellandrene, 0-2% terpinolene.
Method/guideline	ECOSAR
Test Type	Calculated

Species/Strain/Supplier	Fish
Exposure Period	96 hr
Remarks for Test Conditions	The input data are considered to be essentially the same as for *beta*-pinene.
Conclusion Remarks	LC50 = 0.62 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical composition of the mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.).
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure Period	96 hr
Remarks for Test Conditions	The input data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Conclusion Remarks	LC50 = 0.35 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Data Reliability Remarks	The data are obtained by a recognized SAR method and are consistent with chemical composition of the mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, cis-anethole, *trans*-anethole
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Fish
Exposure Period	96 hr

Remarks for Test Conditions	The input data are considered to be essentially the same as for *alpha* and *beta*-pinene.
Conclusion Remarks	LC50 = 0.35 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical composition of the mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

3.2 Acute Toxicity to Aquatic Invertebrates

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	98% pure 1R(+)-isomer. Measured purity 91%
Method/guideline	US EPA
Species/Strain/Supplier	*Daphnia magna*
Test Type	Static 48 hr
GLP	No
Year	1990
Analytical procedures	0, 24, 48 hrs
Remarks for Test Conditions	Sterilized, filtered water from Lake Superior. Changed every 24 hrs. Observations were loss of equilibrium and mortality.
Control response satisfactory?	Yes
Conclusion Remarks	LC50 = 1.44 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Data Reliability Remarks	The data are obtained by a recognized method and are consistent with chemical structure.
Reference	Broderius S., Hammermeister D.and Russom, C. (1990) Toxicity of eight terpenes to Fathead minnows (Pimephales promelas), Daphnids (Daphnia magna), and Algae (Selanastrum capricornutum), Unpublished report..

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Sample consisted mainly of *alpha*-pinene with some camphene, *beta*-pinene and *delta*-3-carene. It was a 50/50 mixture from each of 2 suppliers.

Method/guideline	OECD Guideline 202
Test Type	Semistatic acute toxicity
Species/Strain/Supplier	*Daphnia magna*
GLP	Yes
Year	1993
Test details	Lake water used - renewed at 24 hrs
Remarks for Test Conditions	Stock solution prepared by ultrasonication of 2000 mg/L mixture
Nominal concentrations as mg/L	2,5, 10, 20, 50, 100, 200
EC50, EL50, LC0, at 24,48 hours	EC50 6.74 (48 hr), EC10 4.29 mg/L (48 hr)
Biological observations	Mobility
Control response satisfactory?	Yes
Appropriate statistical evaluations?	Yes
Conclusion Remarks	EC50 = 6.74 (48 hr)
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Data Reliability Remarks	All test levels reported are above water solubility. No analyses for concentrations or for composition.
Reference	Bjornestad E. (1993b) Immobilization test of *alpha*-pinene with the crustacean Daphnia magna, Project 303068, Water Quality Institute, Horsholm, Denmark.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Remarks for Substance	99% pure 1S(-)-isomer. Measured purity 97%
Method/guideline	US EPA
Test Type	Static 48 hr
Species/Strain/Supplier	*Daphnia magna*
GLP	No
Year	1990
Analytical procedures	0, 24, 48 hrs
Remarks for Test Conditions	Sterilized, filtered water from Lake Superior. Changed every 24 hrs. Observations were loss of equilibrium and mortality.
Nominal concentrations as mg/L	0.39,0.78,1.17,1.56, 1.95

Measured concentrations as mg/L	0.30, 0.70, 0.85, 1.18, 1.66
Control response satisfactory?	Yes
Conclusion Remarks	LC50 = 1.25 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Data Reliability Remarks	The data are obtained by a recognized method and are consistent with chemical structure.
Reference	Broderius S., Hammermeister D.and Russom, C. (1990) Toxicity of eight terpenes to Fathead minnows (Pimephales promelas), Daphnids (Daphnia magna), and Algae (Selanastrum capricornutum), Unpublished report.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Camphene 80 % minimum
Method/guideline	Static laboratory method "Methods for acute toxicity tests with fish, macroinvertebrates and amphibians", US EPA, 1975.
Species/Strain/Supplier	*Daphnia magna (Crustacea)*
GLP	Yes
Year	1980
Remarks for Test Conditions	The estimate of concentration of the test substance was made for a mechanically mixed solution.
Control response satisfactory?	Yes
Appropriate statistical evaluations?	Yes
Conclusion Remarks	EC50 = 22 mg/L (48hr): EC0 =<13 mg/L (48hr); EC50 = 46 mg/L (24hr)
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Data Reliability Remarks	The limits of water solubility were exceeded at the temperature tested. Solution was heterogeneous.
Reference	Hoechst AG (1980) Bull. Environ. Contam. Toxicol. 24, 684-691.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Turpentine gum a mixture of 50.8% *alpha*-pinene and 36.9% beta-pinene
Method/guideline	Acute Immobilization Test/OECD Guideline 202
Test Type	Static 48 hour
Species/Strain/Supplier	*Daphnia magna*

GLP	Yes
Year	2001
Remarks for Test Conditions	Daphnia (20), 24 hours old, were exposed to 0,1.0, 10.0 or 100 mg/L of turpentine gum for 48 hours at 20 C. Solutions of gum turpentine were water accommodated fractions prepared by stirring appropriate weight of test substance for 23 hours followed by 1 hour settling time prior to test. Reconstituted water medium used for testing was Elendt's M4 Daphnia medium. Test solutions were monitored for pH, conductivity, alkalinity, and total organic carbon. Daphnia were exposed to 16 hours fluorescent light and 8 hours darkness and were not fed during the 48 hour test period. At 24 and 48 hours, Daphnia were monitored for body movement with a 15 second period.
Control response satisfactory?	Yes
EC50, EL50, LC0, at 24,48 hours	EC50 = 10 to 100 mg/L
Nominal concentrations as mg/L	1.0, 10.0, and 100 mg/L
Remarks for Results	During test, pH values were in the range from 7.75 to 8.01 and dissolved oxygen was 9.0 to 9.2 mg/L at 15+/-1 C.
Conclusion Remarks	The 48 hour NOEC =10 mg/L and the EC50= 10-100 mg/L
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Data Reliability Remarks	The data are obtained by a OECD guideline method and are consistent with chemical structure. Data are considered reliable.
Reference	Long K. W. (2001a) Gum turpentine: Acute toxicity to Daphnia magnat. BL7032/B. Unpublished Report.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	*Daphnia magna*
Conclusion Remarks	LC50 = 0.22 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	*beta*-Pinene
CAS No.	127-91-3

Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	*Daphnia magna*
Conclusion Remarks	LC50 = 0.79 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Substance supported under SIDS.
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	*Daphnia magna*
Conclusion Remarks	LC50 = 0.79 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	*Daphnia magna*
Conclusion Remarks	LC50 = 0.8 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Dihydropinene
CAS No.	473-55-2
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	*Daphnia magna*
Conclusion Remarks	LC50 = 0.8 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Remarks for Substance	Data considered the same as for the isomer *alpha*-pinene
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	*Daphnia magna*
Conclusion Remarks	LC50 = 0.22 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction
CAS No.	65996-96-5
Remarks for Substance	Substance is 92-97% *alpha*-pinene and 1-7% *beta*-pinene.
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	*Daphnia magna*
Remarks for Test Conditions	The data are considered to be essentially the same as for *alpha*-pinene.
Conclusion Remarks	LC50 = 1.44 mg/L (48 hr)

Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical composition of the mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction
CAS No.	65996-97-6
Remarks for Substance	Substance is 78-81% *beta*-Pinene, 8-10% *alpha*-Pinene, 1-5% dipenetene, 1-2% camphene, 1-3% *beta*-phellandrene, 0-2% terpinolene.
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	*Daphnia magna*
Remarks for Test Conditions	The data are considered to be essentially the same as for *beta*-pinene.
Conclusion Remarks	LC50 = 1.25 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical composition of the mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Substance is 60-65% *alpha*-pinene, 25-35% *beta*-pinene, 5-8% monocyclic terpenes (limonene, etc.).
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	*Daphnia magna*
Remarks for Test Conditions	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Conclusion Remarks	LC50 = 1.4 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical composition of the mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	*Daphnia magna*
Remarks for Test Conditions	The data are considered to be essentially the same as for *alpha*- and *beta*-pinene.
Conclusion Remarks	LC50 = 1.4 mg/L (48 hr)
Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical composition of the mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

3.3 Acute Toxicity to Aquatic Plants

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	US EPA ASTM, 1988
Species/Strain/Supplier	Green algae
Exposure Period	48 hrs
Conclusion Remarks	LC50 above water solubility. No effects at saturation.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained by a recognized method and are consistent with chemical structure.
Reference	Broderius S., Hammermeister D.and Russom, C. (1990) Toxicity of eight terpenes to Fathead minnows (Pimephales promelas), Daphnids (Daphnia magna), and Algae (Selanastrum capricornutum), Unpublished report.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	OECD Guideline 201

Species/Strain/Supplier	Green algae
Exposure Period	24, 48, 72 hrs
Biological observations	Growth inhibition at 200 mg/L, Biomass lower at 100 mg/L, EC50 biomass = 278 mg/, growth = 973 mg/L.
Conclusion Remarks	EC50 = 0.973 mg/L (72 hr)
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	No analyses for concentrations or for composition. All test levels reported are above water solubility.
Reference	Petersen G.I. (1993) Growth inhibition test of *alpha*-pinene with the micro algae Selenastrum capricornutum, Project 303068, Water Quality Institute, Horsholm, Denmark.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	US EPA ASTM, 1988
Species/Strain/Supplier	Green algae
Exposure Period	48 hr
Conclusion Remarks	LC50 = 1.44 mg/L
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained by a recognized method and are consistent with chemical structure.
Reference	Broderius S., Hammermeister D.and Russom, C. (1990) Toxicity of eight terpenes to Fathead minnows (Pimephales promelas), Daphnids (Daphnia magna), and Algae (Selanastrum capricornutum), Unpublished report.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	OECD Guideline 201
Species/Strain/Supplier	Algae/Scenedesmus subspicatus
Exposure Period	72 hr
Conclusion Remarks	EC50 > 1000 mg/l -LC50 above water solubility (3.5 mg/L).
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	No analyses for concentrations or for composition. All test levels reported are above water solubility.
Reference	Hoechst AG (1991d) Unveröffentl. Unters. im Auftrag der (Ber.-Nr. 91.1203).

Substance Name	Turpentine gum
CAS No.	9005-90-7
Remarks for Substance	Turpentine gum composed of 50.8% *alpha*-pinene and 36.9% beta-pinene
Method/guideline	OECD Guideline 201
GLP	Yes
Year	2001
Test Type	72-Hour algal growth inhibition test
Species/Strain/Supplier	Selenastrum capricornutum/ATCC22662
NOEC, LOEC or NOEL, LOEL	NOEC
Nominal concentrations as mg/L	1.0, 10.0, and 100 mg/L
Exposure Period	72 hr
Biological observations	The was no significant differences between control and test cultures in algal cell density
Appropriate Statistical Evaluation	Yes (Dunnett, 1964)
Remarks for Test Conditions	Test vessels were inoculated with cultures to yield a nominal cell density of 1x10e4 cells//ml. Test concentrations were prepared with water accommodated fractions of test substance in which mixtures were stirred for 23 hours and settled for 1 hour before use. Six replicate culture of medium control and triplicate cultures of each test concentration were incubated at 24 C under conditions of cool white illumination with shaking at 160 rpm. Samples were removed at 24, 48, and 72 hours and algal cell densities were measured. pH and temperature were monitored during testing.
Conclusion Remarks	EC50= >100 mg/L and NOEC=100 mg/L
Remarks for Results	There was no statistically significant differences in algal cell density between test and control cultures. pH ranged from 7.45 to 7.49 at t=0 to 8.86 to 9..62 at t=72 hours. Temperature remained at 24 C throughout the study.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The data are obtained by a recognized method and are consistent with chemical structure.
Reference	Long K W.J. (2000) Gum turpentine: Toxicity to the green alga Selenastrum capricornutum. Report No. BL/7031/B. Unpublished Report.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8

Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Green algae
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.22 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Green algae
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.79 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Green algae
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.56 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.

Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	*cis*-Pinane
CAS No.	6876-13-7
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Green algae
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.57 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Dihydropinene
CAS No.	473-55-2
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Green algae
Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.57 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	*l-alpha*-Pinene
CAS No.	7785-26-4
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Green algae

Exposure Period	96 hr
Conclusion Remarks	LC50 = 0.22 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical structure.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *alpha*-Pinene fraction
CAS No.	65996-96-5
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Green algae
Conclusion Remarks	LC50 (above water solubility) = 0.65 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Terpenes & Terpenoids, Turpentine oil, *beta*-Pinene fraction
CAS No.	65996-97-6
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Green algae
Exposure Period	48 hr
Conclusion Remarks	LC50 = 1.44 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Turpentine gum
CAS No.	9005-90-7

Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Green algae
Exposure Period	96 hr
Conclusion Remarks	LC50 = 1.44 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Method/guideline	ECOSAR
Test Type	Calculated
Species/Strain/Supplier	Green algae
Exposure Period	96 hr
Conclusion Remarks	LC50 = 1.44 mg/L
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The data are obtained by a recognized SAR method and are consistent with chemical mixture.
Reference	Nabholz V. and Cash, G. (1998) ECOSAR, U.S. Environmental Protection Agency, OPPT Risk Assessment Division.

4 Human Health Toxicity

4.1 Acute Toxicity

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Clear liquid
Method/guideline	Not given
Test Type	Acute oral LD50
Year	1972
Species/strain	Rat/Wistar
Sex	Male
# of animals per sex per dose	10
Vehicle	Oral
Remarks for Test Conditions	Ten rats per dose were administered 0, 2020, 3200, 5000, 7800 mg/kg bw *alpha*-pinene. Food and water was provided ad libitum. Animals were observed for toxic signs and death at 1 and 6 hours after dosing and daily thereafter. Gross necropsies were performed on all 10 rats per dose were administered 0, 2020, 3200, 5000, 7800 mg/kg bw *alpha*-pinene. Food and water was provided ad libitum. Animals were observed for toxic signs and death at 1 and 6 hours after dosing and daily thereafter. Gross necropsies were performed on all survivors.
Value LD50 or LC50 with confidence limits	3700 mg/kg bw (95% confidence limit 2300-5100 mg/kg bw)
Number of deaths at each dose level	2020 mg/kg bw, 2/10; 3200 mg/kg bw, 5/10; 5000 mg/kg bw, 6/10; 7800 mg/bw, 9/10
Remarks for Results	The animals experienced diarrhea and urinary incontinence. Deaths occurred from 2 hours after administration to 2 days following.
Conclusion Remarks	The LD50 calculated from the data was 3700 mg/kg bw (95% C.L. 2300-5100 mg/kg bw).
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards.
References	Moreno O.M. (1972a) Acute oral toxicity in rats. Unpublished report to RIFM.

Substance Name	*beta*-Pinene
CAS No.	127-91-3

Remarks for Substance	Not given
Method/guideline	Litchfield and Wilcoxon
Test Type	Acute oral LD50
Year	1984
Species/strain	Rat/Sprague-Dawley albino
Sex	Male and Female
# of animals per sex per dose	5
Vehicle	Distilled water
Route of Administration	Intraperitoneal injection
Remarks for Test Conditions	A preliminary dose range finding study was performed prior to the LD50 part of the experiment. Based on those results, five male and five female rats were administered 1590, 2150, 2930, 3980 and 5410 mg/kg bw *beta*-pinene. Water was provided ad libitum. Food was returned to the animals one hour after dosing. Animals were observed for signs of toxicity and mortality at 1, 3 and 6 hours after dosing and daily for the remainder of the 14 day observation period. Gross necropsies were performed on all survivors.
Value LD50 or LC50 with confidence limits	LD50: 3388 mg/kg bw for both sexes (95% confidence limit of 2728 to 4209 mg/kg bw); 3387 mg/kg bw for male rats (95% confidence limit of 2495 to 4599 mg/kg bw); 3415 mg/kg bw for female rats (95% confidence limit of 2472 to 4716 mg/kg bw).
Number of deaths at each dose level	1590 mg/kg bw-no deaths; 2150 mg/kg bw, 1M/1F; 2930 mg/kg bw-2M/1F; 3980 mg/kg bw-2M/3F; 5410 mg/kg bw-5M/4F
Conclusion Remarks	The LD50 was reported to be 3388 mg/kg bw for both sexes (95% confidence limit of 2728 to 4209 mg/kg bw); 3387 mg/kg bw for male rats (95% confidence limit of 2495 to 4599 mg/kg bw); 3415 mg/kg bw for female rats (95% confidence limit of 2472 to 4716 mg/kg bw).
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	The basic data given is comparable to guidelines/standards. Small number of animals used.
References	Piccirillo V.J. (1984) Fourteen Day Subacute Toxicity Study in the Rat. Private communication.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Remarks for Substance	Not given
Method/guideline	Limit test
Test Type	Acute oral LD50
Year	1975

Species/strain	Rat/Wistar
Sex	Not reported
# of animals per sex per dose	10
Route of Administration	Oral
Remarks for Test Conditions	Ten rats were administered 5000 mg/kg bw *beta*-pinene. Food and water was provided ad libitum. Gross necropsies were performed on all survivors.
Value LD50 or LC50 with confidence limits	> 5000 mg/kg bw
Number of deaths at each dose level	1 death on observation day 7
Conclusion Remarks	The oral LD50 was reported to be > 5000 mg/kg bw.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards.
References	Moreno O.M. (1975a) Acute oral toxicity in rats. Unpublished report to RIFM.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	Limit test
Test Type	Acute oral LD50
Year	1974
Species/strain	Rat/Wistar
Sex	Not reported
# of animals per sex per dose	10
Route of Administration	Oral
Remarks for Test Conditions	Ten rats were administered 5000 mg/kg bw camphene. Food and water was provided ad libitum. Gross necropsies were performed on all survivors.
Value LD50 or LC50 with confidence limits	> 5000 mg/kg bw
Number of deaths at each dose level	2/10 at 5000 mg/kg bw
Conclusion Remarks	The acute oral LD50 = > 5000 mg/kg
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards.
References	Moreno O.M. (1974a) Acute oral toxicity in rats. Unpublished report to RIFM.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Test Type	Acute oral LD50
Year	1959
Species/strain	Rat/White
Sex	Not reported
# of animals per sex per dose	5
Route of Administration	Oral
Remarks for Test Conditions	3 day observation
Value LD50 or LC50 with confidence limits	5.76 ml/kg (4953 mg/kg)
Number of deaths at each dose level	Not reported
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards. Small number of animals and short observation time.
References	von Skramlik E. (1959) On the toxicity and compatibility of essential oils. Die Pharmazie, 14, 435-445.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Test Type	Acute oral LD50
Year	1972
Species/strain	Rat/Wistar
Sex	Male
# of animals per sex per dose	10
Route of Administration	Oral
Remarks for Test Conditions	Ten rats were administered doses of turpentine oil. Food and water was provided ad libitum. Gross necropsies were performed on all survivors.

Value LD50 or LC50 with confidence limits	4.6 ml/kg (3956 mg/kg)
Number of deaths at each dose level	1/10 at 3.2 (2752 mg/kg), 4/10 at 4 (3440 mg/kg), 6/10 at 5 (4300 mg/kg) and 8/10 at 6.25 (5375 mg/kg) ml/kg bw
Conclusion Remarks	The oral acute LD50 = 4.6 ml/kg (3956 mg/kg)
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Data Reliabilities Remarks	Data collected prior to GLP by method comparable to present guidelines/standards.
References	Moreno O.M. (1972a) Acute oral toxicity in rats. Unpublished report to RIFM.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Method/guideline	Limit test
Test Type	Acute oral LD50
Year	1972
Species/strain	Rat/Wistar
Sex	Male
# of animals per sex per dose	10
Vehicle	Oral
Remarks for Test Conditions	Ten rats were administered 5000 mg/kg bw turpentine oil. Food and water was provided ad libitum. Gross necropsies were performed on all survivors.
Value LD50 or LC50 with confidence limits	< 5000 mg/kg bw
Number of deaths at each dose level	6/10 at 5000 mg/kg bw
Conclusion Remarks	The acute oral LD50 =<5000 mg/kg
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards. Greater than 50% mortality at limit dose.
References	Moreno O.M. (1972a) Acute oral toxicity in rats. Unpublished report to RIFM.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Clear liquid

Method/guideline	Limit test
Test Type	Acute dermal LD50
Year	1972
Species/strain	Rabbits/New Zealand White
Sex	Not reported
# of animals per sex per dose	10
Route of Administration	Dermal
Remarks for Test Conditions	A single 24 hour application was made to the clipped abraded abdominal skin of ten rabbits weighing 2.0 to 2.3 kg. Observations were made for mortality and toxic effects for a period of seven days. Gross necropsies were performed on all animals at the termination of the study.
Value LD50 or LC50 with confidence limits	> 5000 mg/kg bw
Number of deaths at each dose level	0 at 5000 mg/kg
Conclusion Remarks	The LD50 was reported to be > 5000 mg/kg bw.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards.
References	Moreno O.M. (1972b) Acute dermal toxicity of *alpha*-pinene in rabbits. Unpublished report to RIFM.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	Limit test
Test Type	Acute dermal LD50
Year	1975
Species/strain	Rabbits/New Zealand White
Sex	Not reported
# of animals per sex per dose	10
Route of Administration	Dermal
Remarks for Test Conditions	A single 24 hour application was made to the clipped abraded abdominal skin of ten rabbits. Observations were made for mortality and toxic effects for a period of seven days. Gross necropsies were performed on all animals at the termination of the study.
Value LD50 or LC50 with confidence limits	> 5000 mg/kg bw

Number of deaths at each dose level	0 at 5000 mg/kg bw
Conclusion Remarks	The LD50 was reported to be > 5000 mg/kg bw.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards.
References	Moreno O.M. (1975b) Acute dermal toxicity of *beta*-pinene in rabbits. Unpublished report to RIFM.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	Limit test
Test Type	Acute dermal LD50
Year	1974
Species/strain	Rabbits/New Zealand White
Sex	Not reported
# of animals per sex per dose	3 at 2500 mg/kg and 2 at 5000 mg/kg
Route of Administration	Dermal
Remarks for Test Conditions	A single 24 hour application was made to the clipped abraded abdominal skin of ten rabbits. Observations were made for mortality and toxic effects for a period of seven days. Gross necropsies were performed on all animals at the termination of the study.
Value LD50 or LC50 with confidence limits	> 2500 mg/kg bw
Number of deaths at each dose level	1 at 5000 mg/kg bw
Conclusion Remarks	The dermal LD50 was reported to be > 2500 mg/kg bw.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Data Reliabilities Remarks	Data collected prior to GLP by method comparable to present guidelines/standards. Small number of animals used.
References	Moreno O.M. (1974b) Acute dermal toxicity of camphene in rabbits. Unpublished report to RIFM.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Substance is 59% *alpha*-pinene, 24% *beta*-pinene, 5% dipentene, 2% each *beta*-phellandrene, *alpha*-terpineol, & linalool, 1% each methyl chavicol, *cis*-anethole, *trans*-anethole
Test Type	Acute dermal LD50

Year	1972
Species/strain	Rabbits/New Zealand White
Sex	Not reported
# of animals per sex per dose	10
Route of Administration	Dermal
Remarks for Test Conditions	A single 24 hour application was made to the clipped abraded abdominal skin of ten rabbits. Observations were made for mortality and toxic effects for a period of seven days. Gross necropsies were performed on all animals at the termination of the study.
Value LD50 or LC50 with confidence limits	> 2000 mg/kg bw
Number of deaths at each dose level	0/10 at 2000 mg/kg bw
Conclusion Remarks	The dermal LD50 was reported to be > 2000 mg/kg bw.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards.
References	Moreno O. M. (1972c) Acute dermal toxicity of turpentine oil in rabbits. Unpublished report to RIFM.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Test substance was turpentine
Method/guideline	Litchfield and Wilcoxon
Test Type	Inhalation LC50
Year	1967
Species/strain	Rat/Wistar, Mice/Swiss Webster white
Sex	Male
# of animals per sex per dose	10
Route of Administration	Inhalation
Remarks for Test Conditions	Groups of rats were exposed to 12,600-15,700, 15,800-19,800, 19,900-25,000, or 25,100-31,500 mg/m3 of the test substance via inhalation for 1,2, 4, or 6 hours (mice were exposed to the same concentrations for 2 hours only). Turpentine concentrations in six different rat tissues (brain, spleen, kidney, liver, lung, blood) were determined by gas layer chromatography for groups of 3 rats after 1 and 2 hours of exposure or at 15,30, and 60 minutes post-exposure. Lungs of animals were examined histologically.

Value LD50 or LC50 with confidence limits	Rats: 1 hr LC50=19,900 mg/m3 95% C.L. (17,500-22,700 mg/m3); 2 hr: LC50=16,600 mg/m3 95% C.L. (15,900-17,900 mg/m3); 4 hr: LC50=13,700 mg/m3 95% C.L. (11,100-14,800 mg/m3); 6 hr LC50=11,700 mg/m3 95% C.L. (10,600-12,700 mg/m3)
Remarks for Results	There was a dose related increase in respiratory rate and a decrease in tidal volume. Tissue distribution of turpentine following exposure and at 60 minutes post-exposure showed highest concentration in the brain and spleen. There was no evidence of pulmonary lesions induced by turpentine.
Conclusion Remarks	The LC50's for 1-6 hours exposure in rats was in the range from 12,000 -20,000 mg/3); The LC50 for 2 hour exposure in mice was 29,000 mg/m3.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards. Study included well-documented analytical methods and comprehensive tissue analysis.
References	Sperling F., Marcus, W., and Collins, C. (1967) Acute effects of turpentine vapor on rats and mice. Toxicology and Applied Pharmacology 10, 8-20.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	Not given
Test Type	Inhalation ED25
Year	1977
Species/strain	Mouse/CF1
Sex	Female
# of animals per sex per dose	5
Route of Administration	Inhalation
Remarks for Test Conditions	The respiratory irritation potential of fragrance raw materials was assessed in CF-1 females by recording respiration rate using a whole body plethysmograph. Mice were exposed to test materials for 1 minute using a nebulizer for aerosolization in a 2600 ml chamber. Materials shown to be sensory irritants were further tested in mice cannulated via the trachea and compared to an intact mouse breathing through its nose. Comparisons made were between the pre-exposure & exposure rate values for each material at each dose level. Materials were of undetermined purity.
Value LD50 or LC50 with confidence limits	No ED25 was determined. No dose response relationship.
Remarks for Results	Lower tract exposures not performed.
Conclusion Remarks	The ED25 was not reported. No respiratory irritation effects were reported.

Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards.
References	Troy W.R. (1977) Doctoral Dissertation: The comparative respiratory irritation potential of fourteen fragrance raw materials. Unpublished report to RIFM.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Test substance was turpentine
Method/guideline	Litchfield and Wilcoxon
Test Type	Inhalation LC50
Year	1962
Species/strain	Rat/Sprague-Dawley, Guinea pigs/albino, Mice/Swiss white
Sex	Not reported
# of animals per sex per dose	4
Route of Administration	Inhalation
Remarks for Test Conditions	Five groups of four animals each (with the exception of the guinea pigs which had only 2 per group) were exposed to 2400, 4800, 9500, 19000, and 38000 mg/m3 of the test substance via inhalation for six hours (mice were exposed to 2200, 4500, 9000, 18000 and 36000 mg/m3). The animals were observed for fourteen days following the exposure period.
Value LD50 or LC50 with confidence limits	Rats: LC50 = 13500 mg/m3 95% C.L. (6170-29500 mg/m3); Guinea Pigs: LC50 =13500 mg/m3 95% C.L. (6170-29500 mg/m3); Mice: LC50 = 9000 mg/m3 95% C.L. (7000-11600 mg/m3)
Number of deaths at each dose level	Rats: 0 at 2400 mg/m3, 0 at 4800 mg/m3, 0 at 9500 mg/m3, 4 at 19500 mg/m3, 4 at 38000 mg/m3; Guinea Pigs: 0 at 2400 mg/m3, 0 at 4800 mg/m3, 0 at 9500 mg/m3, 2 at 19500 mg/m3, 2 at 38000 mg/m3; Mice: 0 at 2200 mg/m3, 0 at 4500 mg/m3, 2 at 9000 mg/m3, 4 at 18000 mg/m3, 4 at 36000 mg/m3
Conclusion Remarks	The LC50's were calculated as follows: Rats: LC50=13500 mg/3, 95% C.L. (6170-29500 mg/m3); Guinea Pigs: LC50=13500 mg/m3, 95% C.L. (6170-29500 mg/m3); Mice: LC50=9000 mg/m3, 95% C.L. (7000-11600 mg/m3)
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Data collected prior to GLP by method comparable to present guidelines/standards. Small number of animals used.
References	Kohn F. (1962) Acute inhalation toxicity study on turpentine. Industrial Bio-Test Laboratories, Inc., Unpublished report.

4.2 Genetic Toxicity

4.2.1 In vitro Genotoxicity

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	AMES salmonella/microsome mutagenesis assay
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	No
Year	1979
Species/Strain	*Salmonella typhimurium* TA 100 and TA98
Metabolic Activation	Rat liver microsome fraction S9 from Aroclor induced rats
Doses/Concentration	0.5-300 ul/plate
Remarks for Test Conditions	The test material (0.5 ml) was administered directly through a gastric tube to 2 Sprague-Dawley rats with an average weight of 250 grams. The rats were maintained in polyethylene metabolism cages, which are constructed to separate feces from urine. Urine was collected on ice for a 24-hour period, removed and sterilized by filtration. Control urines from rats, which received only water, were collected. Ames tests were conducted in strains TA100 and TA98 with and without *beta*-glucuronidase. 50-300 ul of 24-hour direct urine samples were assayed. After a 48-hour incubation at 37 °C, each assay plate was counted and the number of spontaneous mutants for either TA98 (40) or TA100 (180) were subtracted from the total number of revertants. Routine positive control plates were prepared to verify the reversion properties of each strain: sodium azide and picrolonic acid were used to check TA100 and TA98 respectively. The positive response to mutagenicity with TA100 is defined as any deviation above the upper 99.9% confidence limits of the mean control value. This value (180) is the average number of spontaneous TA100 revertants observed on the control plates. Testing of *alpha*-pinene directly using the AMES assay, as described above, was also performed with metabolic activation.
Results	No mutagenic effects for either the urinary metabolite assay or the assay using *alpha*-pinene directly.
Conclusion Remarks	No evidence of mutagenicity.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Does not meet criteria of today's standard methods but data were obtained by similar methodology and published in a peer reviewed journal.

References	Rockwell P. and Raw I. (1979) A mutagenic screening of various herbs, spices, and food additives. Nutrition and Cancer, Vol. 1. No. 4, 10-15.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	AMES salmonella/microsome mutagenesis assay
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	No
Year	1980
Species/Strain	*Salmonella typhimurium* TA 98, TA 100
Metabolic Activation	With and without rat liver microsome fraction S9 from Aroclor induced rats
Doses/Concentration	0.03, 0.3, 3, 30 umoles/plate (4.08, 40.8, 408, and 4080 ug/plate)
Remarks for Test Conditions	The solvent used was ethanol. Only one replicate was performed for the substances, which tested negative.
Results	No mutagenic effects.
Cytotoxic concentration	>3 umoles/plate
Remarks for Results	Precipitates at 30 umoles/plate (4080 ug/plate); toxic at doses greater than 3 umoles/plate (408 ug/plate).
Conclusion Remarks	No evidence of mutagenicity
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Does not meet criteria of today's standard methods but data were obtained by similar methodology and published in a peer reviewed journal.
References	Florin I., Rutberg, L., Curvall, M., and Enzell, C.R. (1980) Screening of tobacco smoke constituents for mutagenicity using the Ames test. Toxicology, 18, 219-232.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	AMES salmonella/microsome mutagenesis assay
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	No

Year	1989
Species/Strain	*Salmonella typhimurium* TA1535, TA1537, TA1538, TA98, TA100
Metabolic Activation	Rat liver microsome fraction S9 from Aroclor induced rats
Doses/Concentration	25000 ug/plate
Remarks for Test Conditions	After two days incubation at 37 °C, revertant colonies were counted.
Results	No mutagenic effects.
Conclusion Remarks	No evidence of mutagenicity.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study and data published in a peer reviewed journal.
References	Heck J. D., Vollmuth, T. A., Cifone, M. A., Jagannath, D. R., Myhr B., and R.D. Curren (1989) An evaluation of food flavoring ingredients in a genetic toxicity screening battery The Toxicologist, 9(1), 257.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Clear colorless liquid
Method/guideline	AMES salmonella/microsome mutagenesis assay
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	Yes
Year	1984
Species/Strain	*Salmonella typhimurium* TA100, TA98, TA1538, TA1537, TA1535
Metabolic Activation	Aroclor induced rat liver microsomal enzyme preparations
Doses/Concentration	0, 0.1, 0.25, 0.5, 1.0, 2.5, 5.0, 10.0, 25 microliters/plate
Remarks for Test Conditions	Doses were selected based on a preliminary toxicity study of 14 doses in the range from 0.02 ul to 150.0 ul/plate using strain TA100. The test substance was toxic at doses at and above 4.69 ul/plate. The mutagenicity assays were conducted using three plates per dose level. Ethanol was used as the solvent and the negative control. For non-activated assays the positive controls included sodium azide (TA-1535 and TA-100), 2-nitrofluorene (TA-1538 and TA-98), 9-aminoacridine (TA-1537); and for the activated assays, 2-aminoanthracene was used for all strains.
Results	Negative in the absence and presence of metabolic activation. Tests with TA98 were repeated at all doses because of the

	increased number of revertants observed at the 10 microliter dose level in the initial assay. The repeat test was negative.
Cytotoxic concentration	4.69 ul/plate
Conclusion Remarks	*alpha*-Pinene did not exhibit mutagenic activity at any dose level tested.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study.
References	Jagannath D.R. (1984) Mutagenicity evaluation of *alpha*-pinene. Private communication. Unpublished report.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Remarks for Substance	Clear colorless liquid
Method/guideline	AMES salmonella/microsome mutagenesis assay
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	Yes
Year	1983
Species/Strain	*Salmonella typhimurium* TA100, TA98, TA1538, TA1537, TA1535
Metabolic Activation	Aroclor induced rat liver microsomal enzyme preparations
Doses/Concentration	0, 0.01, 0.05, 0.1, 0.5, 1.0, 2.5, 5.0 ul/plate
Remarks for Test Conditions	Doses were selected based on a preliminary toxicity study of 14 doses ranging from 0.02 microliters to 150.0 ul/plate using strain TA100. The test substance completely toxic at doses at and above 4.69 ul/plate. DMSO was used as the solvent and the negative control. Positive controls were used and for non-activated assays included sodium azide (TA-1535 and TA-100), 2-nitrofluorene (TA-1538 and TA-98), 9-aminocridine (TA-1537); for the activated assays, 2-aminoanthracene was used for all strains.
Results	Negative in the absence and presence of metabolic activation.
Cytotoxic concentration	4.69 ul/plate
Conclusion Remarks	*beta*-Pinene did not exhibit mutagenic activity at any dose level tested.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study.
References	DeGraff W.G. (1983) Mutagenicity evaluation of beta-pinene. Private communication. Unpublished report.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	AMES salmonella/microsome mutagenesis assay
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	No
Year	1989
Species/Strain	*Salmonella typhimurium* TA1535, TA1537, TA1538, TA98, TA100
Metabolic Activation	Rat liver microsome fraction S9 from Aroclor induced rats
Doses/Concentration	Up to 5000 ug/plate
Remarks for Test Conditions	After two days incubation at 37°C, revertant colonies were counted.
Results	No mutagenic effects.
Conclusion Remarks	No evidence of mutagenicity.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study and data published in a peer reviewed journal.
References	Heck J. D., Vollmuth, T. A., Cifone, M. A., Jagannath, D. R., Myhr B., and R.D. Curren (1989) An evaluation of food flavoring ingredients in a genetic toxicity screening battery. The Toxicologist, 9(1), 257.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	AMES salmonella/microsome mutagenesis assay
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	No
Year	1980
Species/Strain	*Salmonella typhimurium* TA 98, TA 100
Metabolic Activation	With and without rat liver microsome fraction S9 from Aroclor induced rats
Doses/Concentration	0.03, 0.3, 3, 30 umoles/plate (4.08, 40.8, 408, and 4080 ug/plate)

Remarks for Test Conditions	The solvent used was ethanol. Only one replicate was performed for the substances, which tested negative.
Results	No mutagenic effects.
Cytotoxic concentration	> 3 umoles/plate
Remarks for Results	Toxic at doses greater than 3 umole/plate.
Conclusion Remarks	No mutagenic activity.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Does not meet criteria of today's standard methods but data were obtained by similar methodology and published in a peer reviewed journal.
References	Florin I., Rutberg L., Curvall M., and Enzell C.R. (1980) Screening of tobacco smoke constituents for mutagenicity using the Ames test. Toxicology, 18, 219-232.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	AMES salmonella/microsome mutagenesis assay
Test Type	Reverse mutation
System of Testing	Bacterial
GLP	No
Year	1979
Species/Strain	*Salmonella typhimurium* TA 100 and TA98
Metabolic Activation	Rat liver microsome fraction S9 from Aroclor induced rats
Doses/Concentration	0.5-300 ul/plate
Remarks for Test Conditions	The test material (0.5 ml) was administered directly through a gastric tube to 2 Sprague-Dawley rats with an average weight of 250 gm. The rats were maintained in polyethylene metabolism cages, which are constructed to separate feces from urine. Urine was collected on ice for a 24 hour period, removed and sterilized by filtration. Control urines from rats, which received only water, were collected. Ames tests were conducted in strains TA100 and TA98 with and without *beta*-glucuronidase and with metabolic activation. 50-300 ul of 24 hour direct urine samples were assayed. After a 48 hour incubation at 37 °C, each assay plate was counted and the number of spontaneous mutants for either TA98 (40) or TA100 (180) were subtracted from the total number of revertants. Routine positive control plates were prepared to verify the reversion properties of each strain: sodium azide and picrolonic acid were used to check TA100 and TA98, respectively. The positive response to mutagenicity with TA100 is defined as any deviation above the upper 99.9% confidence limits of the mean

	control value. This value (180) is the average number of spontaneous TA100 revertants observed on the control plates. Testing of camphene directly using the AMES assay as described above was also performed with metabolic activation.
Results	The ether extracts of the 2 hour urine samples of rats fed 0.5 ml of camphene were weakly mutagenic with activation toward TA100 but not TA98. The AMES assay using camphene (not the urinary metabolite) with metabolic activation was negative.
Remarks for results	A weak response was seen in TA100 only with the ether extract of the urinary metabolite and only with metabolic activation. A negative response was reported for camphene in all other extracts tested directly with or without metabolic activation.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Does not meet criteria of today's standard methods but data were obtained by similar methodology and published in a peer reviewed journal.
References	Rockwell P. and Raw, I. (1979) A mutagenic screening of various herbs, spices, and food additives. Nutrition and Cancer, 1(4), 10-15.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	AMES salmonella/microsome mutagenesis assay
Test Type	Reverse mutation
System of Testing	Bacterial
Year	1985
Species/Strain	*Salmonella typhimurium* TA 100, TA98, UTH8414, UTH8413
Metabolic Activation	Rat liver microsome fraction S9 from Aroclor induced male Sprague-Dawley rats
Doses/Concentration	10-1000 ug/plate
Remarks for Test Conditions	The assays were carried out with and without metabolic activation. The test substance was diluted in DMSO and tested at five concentrations in duplicate. Plates were incubated at 37 °C for 48 hours, at which the number of colonies per plate were counted. Sodium azide (10 ug/plate) was the positive control for TA100 without S9; cisplatin (10 ug/plate) was the positive control for UTH8414 and UTH 8413 without S9. 2-Aminoanthracene (10 ug/plate) was the positive control for TA98 with S9.
Results	Negative in the absence and presence of metabolic activation.
Conclusion Remarks	Camphene was not mutagenic in *Salmonella typhimurium* strains TA98, TA100, UTH8413 or UTH8414 with or without metabolic activation.
Data Qualities Reliabilities	Reliability code 2. Reliable with restriction.

Remarks for Data Reliability	Does not meet criteria of today's standard methods but data were obtained by similar methodology and published in a peer reviewed journal.
References	Connor T.H., Theiss J., Hanna H., Monteith D. and Matney T. (1985) Genotoxicity of organic chemicals frequently found in the air of mobile homes. Toxicology Letters, 23, 33-40.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Method/guideline	Unscheduled DNA Synthesis Assay (UDS)
Remarks for Substance	Clear colorless liquid
System of Testing	Rat hepatocytes
Year	1989
Species/Strain	Rat/Fischer and Sprague Dawley adult male
Metabolic Activation	No
Doses/Concentration	0.001, 0.003, 0.01, 0.03, 0.1, 10 ul/ml
Remarks for Test Conditions	Livers were perfused in situ with 0.5 mM EDTA in HEPES buffer (pH 7.2) for four minutes. Cultures of rat liver hepatocytes were incubated with the test material for 18-20 hours. UDS was measures by electronically counting nuclear grains and subtracting the average number of grains in 3 adjacent nuclear sized cytoplasmic areas. 75-150 cells were analyzed for each dose level. The test was considered positive if an increase in net nuclear grain count of at least six grains per nucleus above the solvent control and/or an increase in the percent of nuclei with at least 6 net grains to more than 10% above the negative control value.
Results	Negative at all dose levels
Remarks for Results	The test article did not cause a significant increase in UDS as measured by the mean number of net nuclear grain counts ay any dose level. The positive control, 7,12-dimethylbenz(a)-anthracene (DMBA), induced significant increases in the mean number of net nuclear grain counts compared to the solvent control.
Cytotoxic concentration	Non-toxic at all dose levels
Conclusion Remarks	There was no evidence of genotoxicity based on the results of the rat unscheduled DNA synthesis assay.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study and data published in a peer reviewed journal.
References	Heck J. D., Vollmuth, T. A., Cifone, M. A., Jagannath, D. R., Myhr B., and R.D. Curren (1989) An evaluation of food flavoring ingredients in a genetic toxicity screening battery. The Toxicologist, 9(1), 257.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Method/guideline	Sister Chromatid Exchange in cultured Chinese hamster ovary cells
Test Type	SCE
System of Testing	Chinese hamster ovary cells
Year	1989
Species/Strain	Chinese hamster ovary cells
Metabolic Activation	No
Doses/Concentration	0, 3.3, 10, 33.3, 100, 333, 1000 uM
Statistical Methods	Student's T test (*alpha*=0.05 - 0.001)
Remarks for Test Conditions	The solvent was DMSO. The Chinese hamster K-1 (CHO K-1) cells were exposed to 0.15 micromolar mitomycin C (MMC) for 21 hours and cultured with the test substance for 1 cell cycle. The mean frequency of SCE's was calculated from 3 independent experiments.
Results	No effect
Remarks for Results	*beta*-Pinene did not induce sister chromatid exchanges in CHO cells.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study with acceptable restrictions and data published in a peer reviewed journal.
References	Sasaki Y.F., Imanishi H., Ohta T. and Shirasu Y. (1989) Modifying effects of components of plant essence on the induction of sister-chromatid exchanges in cultured Chinese hamster ovary cells. Mutation Research, 226, 103-110.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	Sister Chromatid Exchange (SCE) in cultured Chinese hamster ovary cells
Test Type	SCE
System of Testing	Chinese hamster ovary cells
Year	1989
Species/Strain	Chinese hamster ovary cells
Metabolic Activation	No

Doses/Concentration	0, 3.3, 10, 33.3, 100, 333, 1000 uM
Statistical Methods	Student's T test (*alpha*=0.05 - 0.001)
Remarks for Test Conditions	The solvent was DMSO. The Chinese hamster K-1 (CHO K-1) cells were exposed to 0.15 micromolar mitomycin C (MMC) for 21 hours and cultured with the test substance for 1 cell cycle. The mean frequency of SCE's was calculated from 3 independent experiments.
Results	No evidence of clastogenicity.
Appropriate statistical evaluations?	No significant increase
Remarks for Remarks	Camphene did not induce sister chromatid exchanges in CHO cells.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Comparable to guideline study with acceptable restrictions and data published in a peer reviewed journal.
References	Sasaki Y.F., Imanishi H., Ohta T. and Shirasu Y. (1989) Modifying effects of components of plant essence on the induction of sister-chromatid exchanges in cultured Chinese hamster ovary cells. Mutation Research, 226, 103-110.

4.2.2 In vivo Genotoxicity

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Technical grade
Method/guideline	OECD Guideline 474
Test Type	Micronucleus assay
GLP	Yes
Year	1991
Species/Strain	NMRI mouse
Sex	Male and Female
Route of Administration	Gavage
Doses/Concentration	0, 4000 mg/kg bw
Exposure Period	Single dose
Remarks for Test Conditions	5 animals/sex/group
NOEL (C)/ LOEL (C)	4000 mg/kg bw

Appropriate statistical evaluations?	Yes
Remarks for Results	The number of micronucleated erythrocytes was not significantly increased in test article treated groups, regardless of sex.
Conclusion Remarks	Under the conditions of the assay, camphene did not increase the incidence of bone marrow micronucleated polychromatic erythrocytes and was concluded to be negative in the micronucleus test using male and female NMRI mice.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	Study performed according to an OECD Guideline 474.
References	Hoechst AG (1991e) Unveröffentl. Unters. (Ber.-Nr. 91.0246).

4.3 Repeat dose Toxicity

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Remarks for Substance	Test substance was polyterpene, which is a resin of *beta*-pinene. Polyterpene prepared as 30 percent suspensions in corn oil.
Method/guideline	90-day sub-acute oral dietary
Species/strain	Rat/Sprague-Dawley
Sex	Male and Female
Route of Administration	Oral (diet)
Doses/concentration Levels	0, 0.01, 0.05, 0.2, 1.0, or 5.0% (100, 500, 2000,10,000, or 50,000 ppm in the diet)
Exposure Period	90 days
Frequency of Treatment	Daily ad libitum feeding
Control Group	2 control groups of 20 rats each (male and female)
Post Exposure Observation Period	None
Remarks for Test Conditions	Five groups of 20 Sprague-Dawley male and female albino rats each were administered in corn oil 0.01, 0.05, 0.2, 1.0 and 5.0% polyterpene in the diet for 90 days. Two groups of control animals, also made up of 20 animals each were administered the corn oil vehicle alone at the same percentage as the test animal. The animals were observed for toxicity including growth, food consumption, mortality, and status of hematopoietic and urinary systems. All animals were sacrificed at the conclusion of the study, and necropsies were performed on all animals. Selected animals from the control and test groups were examined histopathologically.

NOAEL (NOEL)	116.5 mg/kg bw/d
LOAEL (LOEL)	586.2 mg/kg bw/d
Actual Dose Received by Dose Level and Sex	5.82, 29.58, 116.5, 586.2 or 2788.7 mg/kg bw/d
Toxic Response/effects by Dose Level	Elevated liver weights at 1.0 and 5.0% polyterpene
Statistical Evaluation	Yes, *alpha* = 0.05 and 0.01
Remarks for Results	No differences were seen between the test and control animals for the following parameters: growth, food consumption and utilization, mortality, hematologic and urine analyses, gross pathologic findings and histopathological findings. Elevated liver weights were reported for the two highest-level treatment groups. One male from the 0.05% and one male from the 1.0% test groups died during the study. These deaths were attributed to respiratory illness.
Conclusion Remarks	Statistically significant differences in liver weights were reported for the two highest treatment groups. Histopathological examination revealed no differences. Under the conditions of this study, the NOAEL is considered to be 116.5 mg/kg bw/d.
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	There was no quantitative data on the concentration of the monomer *beta*-pinene in the polymeric resin. Therefore, the study is considered unreliable.
References	Calandra J. C. (1962) Ninety-day subacute oral toxicity of polyterpene - albino rats. Industrial Bio-Test Laboratories, Inc. Unpublished report.

Substance Name	Camphene
CAS No.	79-92-5
Method/guideline	OECD Guideline 407
GLP	Yes
Year	1991
Species/strain	Rat/Wistar
Sex	Male and Female
Route of Administration	Gavage
Doses/concentration Levels	0, 62.5, 250, 1000 mg/kg bw/d in sesame oil
Exposure Period	28 days
Frequency of Treatment	Daily
Control Group	Yes
Post Exposure Observation Period	None

Remarks for Test Conditions	5 sex/group
NOAEL (NOEL)	250 mg/kg bw/day (F); <62.5 mg/kg bw/day (M)
LOAEL (LOEL)	1000 mg/kg bw/day
Toxic Response/effects by Dose Level	Increased liver weights at 1000 mg/kg bw/day in both sexes. *alpha*-2-microglobulin nephrotoxicity in males only at all dose levels. Nephrotoxicity effect no relevant to humans.
Statistical Evaluation	Yes
Remarks for Results	In the highest dose group of both sexes, an increase in saliva flow, vacuolization of hepatocytes and elevated liver weights were reported. Male animals exhibited dose dependent deposit in epithelia of the proximal tubules as well as single cell necrosis. The sex-and species-specific nephrotoxic effects have been described for other substances as *alpha*-2-microglobulin nephrotoxicity. The NOEL is 250 mg/kg bw/day for females and <62.5 mg/kg bw/day for males based on the observed nephrotoxicity.
Conclusion Remarks	The NOEL is 250 mg/kg bw/day
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The study was performed according to OECD Guideline 407.
References	Hoechst AG (1991f) Unveröffentl. Unters. (Ber.-Nr. 91.0475)

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Test substance was turpentine
Method/guideline	30 day sub-acute vapor inhalation
GLP	None
Year	1964
Species/strain	Mice/Swiss white
Sex	Female
Route of Administration	Inhalation
Doses/concentration Levels	2400 mg/m3
Exposure Period	30 days
Frequency of Treatment	Six hours\day, five days a week
Control Group	None
Post Exposure Observation Period	None

Remarks for Test Conditions	Twenty Swiss white mice (10 male and 10 female) were exposed to 2.4 mg/L turpentine vapor, determined by gas chromatograph, for six hours each day, five days per week, for thirty days. Food and water were provided ad libitum for the duration of the study. Body weights were recorded at the onset of the study, and at 7, 14, 21 and 30 days during the study. Mortality and abnormal behavioral reactions were recorded daily. Hematologic studies, hemoglobin concentration, erythrocyte count, both total and differential leukocyte counts, were conducted before study initiation and at the conclusion of the study. Necropsies were performed on all animals dying during the study and all animals surviving until the end of the study period. Histopathologic examination of the lung, kidney, liver, heart, trachea, adrenal glands and mesenteric lymph nodes were performed on three males and three females.
LOAEL (LOEL)	2400 mg/m3
Actual Dose Received by Dose Level and Sex	Not determined
Toxic Response/effects by Dose Level	Generalized inactivity during daily exposure to turpentine vapor.
Statistical Evaluation	None
Remarks for Results	Generalized inactivity during daily exposure to turpentine vapor was reported for all animals in the study. No other effects on mortality, body weight, hematologic parameters, gross or histopathological parameters were reported.
Conclusion Remarks	Generalized inactivity during the treatment was reported for Swiss mice exposed to 2400 mg/m3 of turpentine for six hours a day, five days a week for thirty days.
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	This study, conducted prior to GLP, is not considered reliable due to the lack of controls, and single dose design. The results are difficult to interpret due to the lack of controls.
References	Calandra J. C. (1964) 30-Day subacute vapor inhalation toxicity of turpentine. Industrial Bio-Test Laboratories, Inc., Unpublished report.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Test substance was turpentine
Method/guideline	30 day sub-acute vapor inhalation
GLP	No
Year	1964
Species/strain	Rats/Long-Evans hooded
Sex	Female

Route of Administration	Inhalation
Doses/concentration Levels	2400 mg/m3
Exposure Period	30 days
Frequency of Treatment	Six hours\day, five days a week
Control Group	None
Post Exposure Observation Period	None
Remarks for Test Conditions	Twenty Long-Evans hooded rats (10 male and 10 female) were exposed to 2400 mg/m3 turpentine vapor, determined by gas chromatograph, for six hours each day, five days per week, for thirty days. Food and water were provided ad libitum for the duration of the study. Body weights were recorded at the onset of the study, and at 7, 14, 21 and 30 days during the study. Mortality and abnormal behavioral reactions were recorded daily. Hematologic studies, hemoglobin concentration, erythrocyte count, both total and differential leukocyte counts, were conducted before study initiation and at the conclusion of the study. Necropsies were performed on all animals dying during the study and all animals surviving until the end of the study period. Histopathologic examination of the lung, kidney, liver, heart, trachea, adrenal glands and mesenteric lymph nodes were performed on three males and three females.
LOAEL (LOEL)	2400 mg/m3
Actual Dose Received by Dose Level and Sex	Not determined
Toxic Response/effects by Dose Level	Generalized inactivity during daily exposure to turpentine vapor
Remarks for Results	Generalized inactivity during daily exposure to turpentine vapor was reported for all animals in the study. No other effects on mortality, body weight, hematologic parameters, gross or histopathological parameters were reported.
Conclusion Remarks	Generalized inactivity during the treatment was reported for Long-Evans hooded rats exposed to 2400 mg/m3 of turpentine for six hours a day, five days a week for thirty days.
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	This study, conducted prior to GLP, is not considered reliable due to the lack of controls, and single dose design. The results are difficult to interpret due to the lack of controls.
References	Calandra J. C. (1964) 30-Day subacute vapor inhalation toxicity of turpentine. Industrial Bio-Test Laboratories, Inc., Unpublished report.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Test substance was turpentine

Method/guideline	90 day sub-acute vapor inhalation
GLP	No
Year	1963
Species/strain	Guinea pigs/English strain
Sex	Male and Female
Route of Administration	Inhalation
Doses/concentration Levels	4800 mg/m3
Exposure Period	12 weeks
Frequency of Treatment	Six hours\day, five days a week
Control Group	None
Post Exposure Observation Period	None
Remarks for Test Conditions	Ten (5 male and 5 female) English strain guinea pigs were exposed to 4.8 mg/L turpentine vapor, determined by gas chromatograph, for six hours each day, five days per week, for twelve weeks. Food and water were provided ad libitum for the duration of the study. Body weights were recorded at the onset of the study, and at 2, 4, 8, 12 weeks during the study. Mortality and abnormal behavioral reactions were recorded daily. Hematologic studies, hemoglobin concentration, erythrocyte count, both total and differential leukocyte counts, were conducted before study initiation, at one month and at 12 weeks. Necropsies were performed on all animals dying during the study and all animals surviving until the end of the study period. Histopathologic examination of the lung, kidney, liver, heart and trachea were performed.
NOAEL (NOEL)	Not available
LOAEL (LOEL)	4800 mg/m3
Actual Dose Received by Dose Level and Sex	4800 mg/m3 determined by gas chromatography
Toxic Response/effects by Dose Level	None attributed to administration of test material.
Statistical Evaluation	None
Remarks for Results	No growth effects were reported. No deaths were reported. Generalized inactivity was reported for the duration of the study for both sexes. No differences in hematologic values were reported when compared to the pre-test values. Necropsies of the test animals revealed no gross pathological changes, which were related to subacute inhalation of turpentine vapor. Histopathological examination did not reveal any changes which were related to subacute inhalation of turpentine vapor.
Conclusion Remarks	Generalized inactivity was reported for male and female guinea pigs exposed to 4.8 mg/L of turpentine for six hours a day, five days a week for twelve days a week.

Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	This study, conducted prior to GLP, is not considered reliable due to the lack of controls, and single dose design. The results are difficult to interpret due to the lack of controls.
References	Kay J. H. (1963) Subacute vapor inhalation toxicity of turpentine. Industrial Bio-Test Laboratories, Inc., Unpublished report.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Test substance was turpentine oil
Method/guideline	90 day sub-acute vapor inhalation
GLP	No
Year	1963
Species/strain	Rat/Sprague-Dawley
Sex	Male and Female
Route of Administration	Inhalation
Doses/concentration Levels	4800 mg/m3
Exposure Period	12 weeks
Frequency of Treatment	Six hours\day, five days a week
Control Group	None
Post Exposure Observation Period	None
Remarks for Test Conditions	Twenty-five Sprague Dawley albino rats (10 male and 15 female) were exposed to 4800 mg/m3 turpentine vapor, determined by gas chromatograph, for six hours each day, five days per week, for twelve weeks. Food and water were provided ad libitum for the duration of the study. Body weights were recorded at the onset of the study, and at 2, 4, 8, 12 weeks during the study. Mortality and abnormal behavioral reactions were recorded daily. Hematologic studies, hemoglobin concentration, erythrocyte count, both total and differential leukocyte counts, were conducted before study initiation, at one month and at 12 weeks. Necropsies were performed on all animals dying during the study and all animals surviving until the end of the study period. Histopathologic examination of the lung, kidney, liver, heart and trachea were performed.
NOAEL (NOEL)	Not available
LOAEL (LOEL)	4800 mg/m3

Actual Dose Received by Dose Level and Sex	Not determined
Toxic Response/effects by Dose Level	Adverse body weight gain was reported in the female rats. All female rats died within 23 days of the study inception. No effects on mortality were reported for the male rats. Male rats exhibited generalized inactivity during exposure to the vapor throughout the study, while female rats were reported to have experienced generalized inactivity during the first few days of exposure. Later in the study mild to moderate sedation was reported, until severe sedation terminated by death was reported in the female rats.
Statistical Evaluation	None
Remarks for Results	Adverse body weight gain was reported in the female rats. All female rats died within 23 days of the study inception. No effects on mortality were reported for the male rats. Male rats exhibited generalized inactivity during exposure to the vapor throughout the study, while female rats were reported to have experienced generalized inactivity during the first few days of exposure. Later in the study mild to moderate sedation was reported, until severe sedation terminated by death was reported in the female rats. No differences in hematologic values were reported when compared to the pre-test values. Necropsies of the male test animals revealed no gross pathological changes, which were related to subacute inhalation of turpentine vapor. Necropsies of the female test animals revealed severe congestion of the lungs and the absence or incomplete clotting of blood. Histopathological examination did not reveal any changes that were related to subacute inhalation of turpentine vapor in the male rats. Histopathological examination of ten female rats revealed significant changes in the heart and lung, characterized by acute terminal pulmonary hyperemia and edema and acute myocardial anoxic changes. The cause of death of the animals was attributed to cardio-respiratory insufficiency with associated acute myocardial anoxia.
Conclusion Remarks	Depressed weight gain, increased mortality, gross and histopathological changes in the female rats was attributed to exposure of the animals to the test material for six hours a day, five days a week for twelve weeks.
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	This study, conducted prior to GLP, is not considered reliable due to the lack of controls, and single dose design. The results are difficult to interpret due to the lack of controls.
References	Kay J. H. (1963) Subacute vapor inhalation toxicity of turpentine. Industrial Bio-Test Laboratories, Inc., Unpublished report.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Test substance was turpentine

Method/guideline	30 day sub-acute vapor inhalation
GLP	No
Year	1964
Species/strain	Rats/Sprague-Dawley
Sex	Female
Route of Administration	Inhalation
Doses/concentration Levels	2400 mg/m3
Exposure Period	30 days
Frequency of Treatment	Six hours\day, five days a week
Control Group	None
Post Exposure Observation Period	None
Remarks for Test Conditions	Ten Sprague Dawley female albino rats were exposed to 2400 mg/m3 turpentine vapor, determined by gas chromatograph, for six hours each day, five days per week, for thirty days. Food and water were provided ad libitum for the duration of the study. Body weights were recorded at the onset of the study, and at 7, 14, 21 and 30 days during the study. Mortality and abnormal behavioral reactions were recorded daily. Hematologic studies, hemoglobin concentration, erythrocyte count, both total and differential leukocyte counts, were conducted before study initiation and at the conclusion of the study. Necropsies were performed on all animals dying during the study and all animals surviving until the end of the study period. Histopathologic examination of the lung, kidney, liver, heart, trachea, adrenal glands and mesenteric lymph nodes were performed on all of the albino rats.
LOAEL (LOEL)	2400 mg/m3
Actual Dose Received by Dose Level and Sex	Not determined
Toxic Response/effects by Dose Level	Generalized inactivity during daily exposure to turpentine vapor.
Statistical Evaluation	None
Remarks for Results	Generalized inactivity during daily exposure to turpentine vapor was reported for all animals in the study. No other effects on mortality, body weight, hematologic parameters, gross or histopathological parameters were reported.
Conclusion Remarks	Generalized inactivity during the treatment was reported for Sprague-Dawley rats exposed to 2400 mg/m3 of turpentine for six hours a day, five days a week for thirty days.
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	This study, conducted prior to GLP, is not considered reliable due to the lack of controls, and single dose design. The results are difficult to interpret due to the lack of controls.

References	Calandra J. C. (1964) 30-Day subacute vapor inhalation toxicity of turpentine. Industrial Bio-Test Laboratories, Inc., Unpublished report.

Substance Name	Turpentine oil
CAS No.	8006-64-2
Remarks for Substance	Test substance was turpentine oil
Method/guideline	90-day sub-acute vapor inhalation
GLP	No
Year	1964
Species/strain	Dog/Beagle
Sex	Male and Female
Route of Administration	Inhalation
Doses/concentration Levels	4.8 mg/L (4800 mg/m3)
Exposure Period	12 weeks
Frequency of Treatment	Six hours\day, five days a week
Control Group	None
Post Exposure Observation Period	None
Remarks for Test Conditions	Two Beagle dogs (male and female) were exposed to 4800 mg/m3 turpentine vapor, determined by gas chromatograph, for six hours each day, five days per week, for twelve weeks. Food and water were provided ad libitum for the duration of the study. Body weights were recorded at the onset of the study, and at 2, 4, 8, 12 weeks during the study. Mortality and abnormal behavioral reactions were recorded daily. Hematologic studies, hemoglobin concentration, erythrocyte count, both total and differential leukocyte counts, were conducted before study initiation, at one month and at 12 weeks. Necropsies were performed on all animals dying during the study and all animals surviving until the end of the study period. Histopathologic examination of the lung, kidney, liver, heart and trachea were performed.
NOAEL (NOEL)	Not available
LOAEL (LOEL)	4800 mg/m3
Actual Dose Received by Dose Level and Sex	Not determined
Toxic Response/effects by Dose Level	Slight ataxia and generalized inactivity was reported for both sexes during the exposure period
Statistical Evaluation	None

Remarks for Results	No growth effects were reported. No deaths were reported. Slight ataxia was reported for both sexes for the first three days of the study during the exposure period. Generalized inactivity was reported for the remainder of the study for both sexes. No differences in hematologic values were reported when compared to the pre-test values. Necropsies of the test animals revealed no gross pathological changes, which were related to subacute inhalation of turpentine vapor. Histopathological examination did not reveal any changes which were related to subacute inhalation of turpentine vapor.
Conclusion Remarks	Slight ataxia and generalized inactivity was reported for a male and female beagle dog exposed to 4800 mg/m3 of turpentine for six hours a day, five days a week for twelve days a week.
Data Qualities Reliabilities	Reliability code 3. Not reliable.
Remarks for Data Reliability	This study, conducted prior to GLP, is not considered reliable due to the lack of controls, and single dose design. The results are difficult to interpret due to the lack of controls.
References	Kay J. H. (1963) Subacute vapor inhalation toxicity of turpentine. Industrial Bio-Test Laboratories, Inc., Unpublished report.

4.4 Reproductive Toxicity

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Test material a mixture of 85-90% terpene hydrocarbons and < 10% oxygenated terpene hydrocarbons. The major bicyclic terpene hydrocarbon constituents of the formula C10H16 are *alpha*-pinene (20-25%), *beta*-pinene (15-18%) and sabinene (38-42%). Sabinene is 2-methylenebicyclo[3.1.0]hexane, 5-isopropyl- and beta-pinene is 2-methylenebicyclo[3.1.1]heptane, 2,6,6-trimethyl-.
Test Type	One generation reproduction study
GLP	No
Year	1973
Species/Strain	Mouse/CD-1 outbred
Sex	Female
Route of Administration	Oral (gavage)
Duration of Test	Days 6 to 15 of gestation
Doses/Concentration	0(control), 6, 26, 120, 560 mg/kg bw/day and a positive control of 150 mg/kg bw/day of aspirin.

Premating Exposure period for males	None
Premating Exposure period for females	None
Frequency of Treatment	Daily
Control Group and Treatment	Control group received corn oil vehicle (10 ml//kg); Positive control received 150 mg/kg bw/day of aspirin in corn oil.
Remarks for Test Conditions	Study measured parameters for reproductive and developmental toxicity. In the reproductive segment of the study, virgin adult female CD-1 outbred mice were gang-housed in plastic disposable cages in a temperature- and humidity-controlled room. Animals were given free access to food and fresh tap water. There were mated with untreated young adult males and observation of vaginal sperm plugs was considered day 0 of gestation. Beginning on Day 6 and continuing daily through Day 15 of gestation, females were given 0, 6, 26, 120, or 560 mg/kg bw of the test material (FDA 71-28) by gavage in corn oil. A positive control group received 150 mg/kg bw/day of aspirin. Body weights were recorded on days 0, 6, 11, 15, and 17 of gestation. Females were observed daily for appearance and behavior. Food consumption and body weight were monitored to eliminate any abnormalities that may be associated with anorexia in pregnant females. On Day 17 all dams were subjected to Caesarian section and the number of implantation sites, resorption sites, live fetuses, dead fetuses, and body weight of live pups were recorded. Gestation index, mortality, gross pathology incidence of the dam urogenital tract, number of implantation sites, number of corpora lutea, litter size and weights, sex and sex ratio of pups, and gross abnormalities to pups were reported. The urogenital tract of each dam was examined for anatomical abnormalities. One-third of fetuses of each litter underwent detailed visceral examination at 10x magnification. The remaining two-thirds were stained with alizarin red S dye/KOH and examined for skeletal defects.
NOAEL(NOEL)	560 mg/kg bw/day
Actual dose received by dose level and sex	560 mg/kg bw/day
Parental data and F1 as Appropriate	Data for number of females mated/pregnant at each dose level: 0 mg/kg bw, 24/21; 150 mg/kg bw of aspirin, 30/20; 6 mg/kg bw, 30/22; 26 mg/kg bw, 31/21; 120 mg/kg bw, 22/21; 560 mg/kg bw, 32/20. All pregnant females survived to sacrifice on Day 17. There was no significant difference in dam body weights between controls and any test group measured at Days 0, 6, 11, 15, or 17 of the study. None of the pregnant females died or aborted before Day 17and all litters were alive on Day 17 sacrifice. Average number of corpora lutea/dam mated were similar for controls and treatment groups: 0 mg/kg bw, 12.5; 150 mg/kg bw aspirin, 12.0; 6 mg/kg bw, 12.3; 26 mg/kg bw, 11.2; 120 mg/kg bw, 12.9; 560 mg/kg bw, 11.2. The average number of implantation sites/dam and % partial resorptions were similar for all groups:0 mg/kg bw, 11.8 and 19%; 150 mg/kg bw aspirin, 11.3 and 45%; 6 mg/kg bw, 12.5 and 45%; 26 mg/kg bw, 11.9 and 28%; 120 mg/kg bw, 10.5 and 28%; 560

	mg/kg bw, 11.0 and 25%. Based on bodyweight changes, clinical observation, and gross examination of the urogenital tract, was no evidence of toxicity to dams.
Offspring Toxicity F1 and F2	Based on gross examination of live pups, visceral examination and skeletal examination there were no signs of toxicity to offspring. The total number of live fetuses, average number of live fetuses per dam, sex ratio, number of dead fetuses, and average fetal weight were not different between control and treatment groups. Total number of live fetuses/dead fetuses/average fetal weight are recorded below: 0 mg/kg bw, 240/3/0.88g; 150 mg/kg bw aspirin, 207/2/0.80g; 6 mg/kg bw, 253/0/0.87g; 26 mg/kg bw, 242/1/0.87g; 120 mg/kg bw, 210/3/0.87g; 560 mg/kg bw, 206/5/0.81g.
Conclusion Remarks	The administration of up to and including 560 mg/kg bw/day of test article FDA 71-28 to pregnant mice on days 6 through 15 of gestation had no effects on nidation, maternal survival or fetal survival. The number and types of abnormalities seen in tissues of the dam or pups of the test groups did not differ for the number and type occurring spontaneously in the positive or negative controls.
Data Reliabilities Qualities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
References	Morgareidge K. (1973a) Teratologic evaluation of FDA 71-28 in mice. Contract No. FDA 71-260. Unpublished Report.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Test material a mixture of 85-90% terpene hydrocarbons and < 10% oxygenated terpene hydrocarbons. The major bicyclic terpene hydrocarbon constituents of the formula C10H16 are *alpha*-pinene (20-25%), *beta*-pinene (15-18%) and sabinene (38-42%). Sabinene is 2-methylenebicyclo[3.1.0]hexane, 5-isopropyl- and beta-pinene is 2-methylenebicyclo[3.1.1]heptane, 2,6,6-trimethyl-.
Test Type	One generation reproduction study
GLP	No
Year	1973
Species/Strain	Hamster/adult golden
Sex	Female
Route of Administration	Oral (gavage)
Duration of Test	Days 6 to 15 of gestation
Doses/Concentration	0(control), 6, 28, 130, or 600 mg/kg bw/day and a positive control of 250 mg/kg bw/day of aspirin.

Premating Exposure period for males	None
Premating Exposure period for females	None
Frequency of Treatment	Daily
Control Group and Treatment	Control group received corn oil vehicle (10 ml//kg); Positive control received 250 mg/kg bw/day of aspirin in corn oil.
Remarks for Test Conditions	Study measured parameters for reproductive and developmental toxicity. In the reproductive segment of the study, groups (26-28/dose/group) of virgin adult female hamster were individually housed in mess-bottom cages in a temperature- and humidity-controlled room. Animals were given free access to food and fresh tap water. There were mated one to one with untreated adult males and the appearance of motile sperm in the vaginal sperm was considered day 0 of gestation. Beginning on Day 6 and continuing daily through Day 10 of gestation, females were given 0, 6, 28, 130, or 600 mg/kg bw of the test material (FDA 71-28) by gavage in corn oil. A positive control group received 250 mg/kg bw/day of aspirin. Body weights were recorded on days 0, 8, 10, and 14 of gestation. Females were observed daily for appearance and behavior. Food consumption and body weight were monitored to eliminate any abnormalities that may be associated with anorexia in pregnant females. On Day 14 all dams were subjected to Caesarian section and the number of implantation sites, resorption sites, live fetuses, dead fetuses, and body weight of live pups were recorded. Gestation index, mortality, gross pathology incidence of the dam urogenital tract, number of implantation sites, number of corpora lutea, litter size and weights, sex and sex ratio of pups, and gross abnormalities to pups were reported. The urogenital tract of each dam was examined for anatomical abnormalities. One-third of fetuses of each litter underwent detailed visceral examination at 10x magnification. The remaining two-thirds were stained with alizarin red S dye/KOH and examined for skeletal defects.
NOAEL(NOEL)	600 mg/kg bw/day
Actual dose received by dose level and sex	600 mg/kg bw/day
Parental data and F1 as Appropriate	Data for number of females mated/pregnant at each dose level: 0 mg/kg bw, 27/21; 250 mg/kg bw of aspirin, 26/19; 6 mg/kg bw, 28/19; 28 mg/kg bw, 26/21; 130 mg/kg bw, 28/20; 600 mg/kg bw, 27/23. All pregnant females survived to sacrifice on Day 14. There was no significant difference in dam body weights between controls and any test group measured at Days 0, 6, 8, 10, or 14 of the study. One death each was reported in the two control groups and in the two highest dose groups before day 14. All litters were alive on Day 14 sacrifice. Average number of corpora lutea/dam mated were similar for controls and treatment groups: 0 mg/kg bw, 10.3; 250 mg/kg bw aspirin, 9.9; 6 mg/kg bw, 9.6; 28 mg/kg bw, 11.4; 130 mg/kg bw, 9.6; 600 mg/kg bw, 11.2. The average number of implantation sites/dam and % partial resorptions were similar for all groups:0 mg/kg bw, 11.7 and 15%; 250 mg/kg bw aspirin, 11.3 and 39%; 6 mg/kg bw, 12.1 and 32%; 28 mg/kg bw, 11.9

	and 38%; 130 mg/kg bw, 11.5 and 42%; 600 mg/kg bw, 12.1 and 23%. Based on bodyweight changes, clinical observation, and gross examination of the urogenital tract, was no evidence of toxicity to dams.
Offspring Toxicity F1 and F2	Based on gross examination of live pups, visceral examination, and skeletal examination there were no signs of toxicity to offspring in either the control or test groups. The total number of live fetuses, average number of live fetuses per dam, sex ratio, and average fetal weight were not different between control and treatment groups. A small number of dead fetuses were reported at the three highest dose levels. The incidence of mortality was not dose related. Total number of live fetuses/dead fetuses/average fetal weight are recorded below: 0 mg/kg bw, 229/0/1.76g; 250 mg/kg bw aspirin, 192/0/1.74g; 6 mg/kg bw, 217/0/1.66g; 28 mg/kg bw, 230/7/1.73g; 130 mg/kg bw, 195/5/1.72g; 600 mg/kg bw, 258/1/1.70g.
Conclusion Remarks	The administration of up to and including 600 mg/kg bw/day of test article FDA 71-28 to pregnant golden hamsters on days 6 through 10 of gestation had no effects on nidation, maternal survival or fetal survival. The number and types of abnormalities seen in tissues of the dam or pups of the test groups did not differ for the number and type occurring spontaneously in the positive or negative controls.
Data Reliabilities Qualities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
References	Morgareidge K. (1973b) Teratologic evaluation of FDA 71-28 in hamsters. Contract No. FDA 71-260. Unpublished Report.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Test material a mixture of 85-90% terpene hydrocarbons and < 10% oxygenated terpene hydrocarbons. The major bicyclic terpene hydrocarbon constituents of the formula C10H16 are *alpha*-pinene (20-25%), *beta*-pinene (15-18%) and sabinene (38-42%). Sabinene is 2-methylenebicyclo[3.1.0]hexane, 5-isopropyl- and beta-pinene is 2-methylenebicyclo[3.1.1]heptane, 2,6,6-trimethyl-.
Test Type	One generation reproduction study
GLP	No
Year	1973
Species/Strain	Rat/Wistar adult
Sex	Female
Route of Administration	Oral (gavage)

Duration of Test	Day 14 of gestation
Doses/Concentration	0(control), 3, 12, 56, or 260 mg/kg bw/day and a positive control of 250 mg/kg bw/day of aspirin.
Premating Exposure period for males	None
Premating Exposure period for females	None
Frequency of Treatment	Daily
Control Group and Treatment	Control group received corn oil vehicle (10 ml//kg); Positive control received 250 mg/kg bw/day of aspirin in corn oil.
Remarks for Test Conditions	Study measured parameters for reproductive and developmental toxicity. In the reproductive segment of the study, virgin adult female Wistar were individually housed in mess-bottom cages in a temperature- and humidity-controlled room. Animals were given free access to food and fresh tap water. There were mated with untreated young adult males and observation of vaginal sperm plugs was considered day 0 of gestation. Beginning on Day 6 and continuing daily through Day 15 of gestation, females were given 0, 3, 2, 56, or 260 mg/kg bw of the test material (FDA 71-28) by gavage in corn oil. A positive control group received 250 mg/kg bw/day of aspirin. Body weights were recorded on days 0, 6, 11, 15, and 20 of gestation. Females were observed daily for appearance and behavior. Food consumption and body weight were monitored to eliminate any abnormalities that may be associated with anorexia in pregnant females. On Day 20 all dams were subjected to Caesarian section and the number of implantation sites, resorption sites, live fetuses, dead fetuses, and body weight of live pups were recorded. Gestation index, mortality, gross pathology incidence of the dam urogenital tract, number of implantation sites, number of corpora lutea, litter size and weights, sex and sex ratio of pups, and gross abnormalities to pups were reported. The urogenital tract of each dam was examined for anatomical abnormalities. One-third of fetuses of each litter underwent detailed visceral examination at 10x magnification. The remaining two-thirds were stained with alizarin red S dye/KOH and examined for skeletal defects.
NOAEL(NOEL)	260 mg/kg bw/day
Actual dose received by dose level and sex	260 mg/kg bw/day
Parental data and F1 as Appropriate	Data for number of females mated/pregnant at each dose level: 0 mg/kg bw, 25/23; 250 mg/kg bw of aspirin, 25/22; 3 mg/kg bw, 25/25; 12 mg/kg bw, 25/23; 56 mg/kg bw, 25/22; 260 mg/kg bw, 25/21. All pregnant females survived to sacrifice on Day 20. There was no significant difference in dam body weights between controls and any test group measured at Days 0, 6, 11, 15, or 20 of the study. None of the pregnant females died or aborted before Day 20 and all litters were alive on Day 20 sacrifice. Average number of corpora lutea/dam mated were similar for controls and treatment groups: 0 mg/kg bw, 12.8; 250 mg/kg bw aspirin, 11.1; 3 mg/kg bw, 12.7; 12 mg/kg bw,12.5; 56 mg/kg bw, 11.6; 260 mg/kg bw,10.7. The average number of implantation sites/dam and % partial resorptions

	were similar for all groups:0 mg/kg bw, 11.9 and 9%; 250 mg/kg bw aspirin, 11.1 and 32%; 3 mg/kg bw, 12 and 12%; 12 mg/kg bw, 11.8 and 4%; 56 mg/kg bw, 11.1 and 5%; 260 mg/kg bw, 11.1 and 5%. Based on bodyweight changes, clinical observation, and gross examination of the urogenital tract, there was no evidence of toxicity to dams.
Offspring Toxicity F1 and F2	Based on gross examination of live pups, visceral examination and skeletal examination there were no signs of toxicity to offspring in either the control or test groups. The total number of live fetuses, average number of live fetuses per dam, sex ratio, number of dead fetuses, and average fetal weight were not different between control and treatment groups. Total number of live fetuses/dead fetuses/ average fetal weight are recorded below: 0 mg/kg bw, 270/1/3.70g; 250 mg/kg bw aspirin, 216/2/2.68g; 3 mg/kg bw, 295/1/3.91g; 12 mg/kg bw, 271/0/3.73g; 56 mg/kg bw, 242/1/3.95g; 260 mg/kg bw, 230/0/3.76g.
Conclusion Remarks	The administration of up to and including 260 mg/kg bw/day of test article FDA 71-28 to pregnant Wistar rats on days 6 through 15 of gestation had no effects on nidation, maternal survival or fetal survival. The number and types of abnormalities seen in tissues of the dam or pups of the test groups did not differ for the number and type occurring spontaneously in the positive or negative controls.
Data Reliabilities Qualities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
References	Morgareidge K. (1973c) Teratologic evaluation of FDA 71-28 in rats. Contract No. FDA 71-260. Unpublished Report.

4.5 Developmental/Teratogenicity Toxicity

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Test material a mixture of 85-90% terpene hydrocarbons and < 10% oxygenated terpene hydrocarbons. The major bicyclic terpene hydrocarbon constituents of the formula C10H16 are *alpha*-pinene (20-25%), beta-pinene (15-18%) and sabinene (38-42%). Sabinene is 2-methylenebicyclo[3.1.0]hexane, 5-isopropyl- and beta-pinene is 2-methylenebicyclo[3.1.1]heptane, 2,6,6-trimethyl-.
Test Type	Teratology study
GLP	Pre-GLP
Year	1973
Species/strain	Mouse/CD-1 outbred

Sex	Female
Route of Administration	Gavage
Duration of Test	10 days
Doses/concentration Levels	0(control), 6, 26, 120, 560 mg/kg bw/day and a positive control of 150 mg/kg bw/day of aspirin
Exposure Period	Days 6 to 15 of gestation
Frequency of Treatment	Daily
Control Group and Treatment	Control group received corn oil vehicle (10 ml//kg); Positive control received 150 mg/kg bw/day of aspirin in corn oil
Remarks for Test Conditions	Study measured parameters for reproductive and developmental toxicity. In the study, virgin adult female CD-1 outbred mice were gang-housed in plastic disposable cages in a temperature- and humidity-controlled room. Animals were given free access to food and fresh tap water. There were mated with untreated young adult males and observation of vaginal sperm plugs was considered day 0 of gestation. Beginning on Day 6 and continuing daily through Day 15 of gestation, groups (20-22/group) of pregnant females were given 0, 6, 26, 120, or 560 mg/kg bw of the test material (FDA 71-28) by gavage in corn oil. A positive control group received 150 mg/kg bw/day of aspirin. Body weights were recorded on days 0, 6, 11, 15, and 17 of gestation. Females were observed daily for appearance and behavior. Food consumption and body weight were monitored to eliminate any abnormalities that may be associated with anorexia in pregnant females. On Day 17 all dams were subjected to Caesarian section and the number of implantation sites, resorption sites, live fetuses, dead fetuses, and body weight of live pups were recorded. Gestation index, mortality, gross pathology incidence of the dam urogenital tract, number of implantation sites, number of corpora lutea, litter size and weights, sex and sex ratio of pups, and gross abnormalities to pups were reported (these data were described in the robust summary for reproductive effects for the test material). The urogenital tract of each dam was examined for anatomical abnormalities. One-third of fetuses of each litter underwent detailed visceral examination at 10x magnification. The remaining two-thirds were stained with alizarin red S dye/KOH and examined for skeletal defects (the maternal and developmental fetal effects are discussed in this robust summary).
NOAEL (NOEL) maternal toxicity	560 mg/kg bw/day
NOAEL (NOEL) developmental toxicity	560 mg/kg bw/day
Actual dose received by dose level and sex	0, 6, 26, 120, or 560 mg/kg bw of the test material (FDA 71-28)
Maternal data with dose level	Daily clinical observation and measurement of body weight gain failed to show any differences between control and test groups of female mice. The number pregnant and % pregnancy were similar for all dose and control groups. No abortions were observed in any group.

Fetal Data with Dose Level	The average fetal weight of treatment and control groups were not statistically different (p>0.05). The total number of live fetuses was similar for test and control groups. Also, there was no significant difference in the number of dead fetuses between test and control groups. Skeletal examination of sternebrae showed no significant differences in the incidence of incomplete ossification or missing sternebrae for test and control groups. Likewise the incidences of fetuses with more than 13 ribs, incomplete ossification of vertebrae and extremities, incomplete skull closures were similar for test and control animals. Visceral examination failed to reveal any evidence of abnormalities at any dose level.
Conclusion Remarks	There was no evidence of maternal toxicity or developmental toxicity at dose levels up to and including 560 mg/kg bw/day of test material.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
References	Morgareidge K. (1973a) Teratologic evaluation of FDA 71-28 in mice. Contract No. FDA 71-260. Unpublished Report.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Test material a mixture of 85-90% terpene hydrocarbons and < 10% oxygenated terpene hydrocarbons. The major bicyclic terpene hydrocarbon constituents of the formula C10H16 are *alpha*-pinene (20-25%), beta-pinene (15-18%) and sabinene (38-42%). Sabinene is 2-methylenebicyclo[3.1.0]hexane, 5-isopropyl- and beta-pinene is 2-methylenebicyclo[3.1.1]heptane, 2,6,6-trimethyl-.
Test Type	Teratology study
GLP	Pre-GLP
Year	1973
Species/strain	Rat/Wistar adult
Sex	Female
Route of Administration	Gavage
Duration of Test	10 days
Doses/concentration Levels	0(control), 3, 12, 56, 260 mg/kg bw/day and a positive control of 250 mg/kg bw/day of aspirin
Exposure Period	Days 6 to 15 of gestation
Frequency of Treatment	Daily
Control Group and Treatment	Control group received corn oil vehicle (10 ml//kg); Positive control received 250 mg/kg bw/day of aspirin in corn oil

Remarks for Test Conditions	Study measured parameters for reproductive and developmental toxicity. In the study, virgin adult female rats were individually housed in mess bottom cages in a temperature- and humidity-controlled room. Animals were given free access to food and fresh tap water. There were mated with untreated young adult males and observation of vaginal sperm plugs was considered day 0 of gestation. Beginning on Day 6 and continuing daily through Day 15 of gestation, groups (21-25/group) of pregnant females were given 0, 6, 26, 120, or 260 mg/kg bw of the test material (FDA 71-28) by gavage in corn oil. A positive control group received 250 mg/kg bw/day of aspirin. Body weights were recorded on days 0, 6, 11, 15, and 20 of gestation. Females were observed daily for appearance and behavior. Food consumption and body weight were monitored to eliminate any abnormalities that may be associated with anorexia in pregnant females. On Day 20 all dams were subjected to Caesarian section and the number of implantation sites, resorption sites, live fetuses, dead fetuses, and body weight of live pups were recorded. Gestation index, mortality, gross pathology incidence of the dam urogenital tract, number of implantation sites, number of corpora lutea, litter size and weights, sex and sex ratio of pups, and gross abnormalities to pups were reported (these data were described in the robust summary for reproductive effects for the test material). The urogenital tract of each dam was examined for anatomical abnormalities. One-third of fetuses of each litter underwent detailed visceral examination at 10x magnification. The remaining two-thirds were stained with alizarin red S dye/KOH and examined for skeletal defects (the maternal and developmental fetal effects are discussed in this robust summary).
NOAEL (NOEL) maternal toxicity	260 mg/kg bw/day
NOAEL (NOEL) developmental toxicity	260 mg/kg bw/day
Actual dose received by dose level and sex	0, 3, 12, 56, or 260 mg/kg bw of the test material (FDA 71-28)
Maternal data with dose level	Daily clinical observation and measurement of body weight gain failed to show any differences between control and test groups of female rats. The number pregnant and % pregnancy were similar for all dose and control groups. No abortions were observed in any group.
Fetal Data with Dose Level	The average fetal weight of treatment and control groups were not statistically different ($p>0.05$). The total number of live fetuses was similar for test and control groups. Also, there was no significant difference in the number of dead fetuses between test and control groups. Except for positive control group, skeletal examination of sternebrae showed no significant differences in the incidence of incomplete ossification or missing sternebrae for test and untreated control group. Likewise the incidences of fetuses with more than 13 ribs, incomplete ossification of vertebrae and extremities, incomplete skull closure were similar for test and the untreated control group except for the positive aspirin-treated control group in which increases in incidences of these skeletal effects were observed. Visceral examination failed to reveal any evidence of

	abnormalities at any dose level.
Conclusion Remarks	There was no evidence of maternal toxicity or developmental toxicity at dose levels up to and including 260 mg/kg bw/day of test material.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
References	Morgareidge K. (1973c) Teratologic evaluation of FDA 71-28 in rats. Contract No. FDA 71-260. Unpublished Report.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	Test material a mixture of 85-90% terpene hydrocarbons and < 10% oxygenated terpene hydrocarbons. The major bicyclic terpene hydrocarbon constituents of the formula C10H16 are *alpha*-pinene (20-25%), beta-pinene (15-18%) and sabinene (38-42%). Sabinene is 2-methylenebicyclo[3.1.0]hexane, 5-isopropyl- and beta-pinene is 2-methylenebicyclo[3.1.1]heptane, 2,6,6-trimethyl-.
Test Type	Teratology study
GLP	Pre-GLP
Year	1973
Species/strain	Hamster/golden
Sex	Female
Route of Administration	Gavage
Duration of Test	5 days
Doses/concentration Levels	0(control), 6, 28, 130, 600 mg/kg bw/day and a positive control of 250 mg/kg bw/day of aspirin
Exposure Period	Days 6 to 15 of gestation
Frequency of Treatment	Daily
Control Group and Treatment	Control group received corn oil vehicle (10 ml//kg); Positive control received 250 mg/kg bw/day of aspirin in corn oil
Remarks for Test Conditions	Study measured parameters for reproductive and developmental toxicity. In the study, virgin adult female hamsters were individually housed in mess bottom cages in a temperature- and humidity-controlled room. Animals were given free access to food and fresh tap water. There were mated one to one with untreated young adult males and the appearance of motile sperm in the vaginal sperm was considered day 0 of gestation. Beginning on Day 6 and continuing daily through Day 10 of gestation, groups (19-23/group) of pregnant females were given 0, 6, 28, 130, or 600 mg/kg bw of the test material (FDA 71-28) by gavage in corn oil. A positive control group received

	250 mg/kg bw/day of aspirin. Body weights were recorded on days 0, 6, 8, 10, and 14 of gestation. Females were observed daily for appearance and behavior. Food consumption and body weight were monitored to eliminate any abnormalities that may be associated with anorexia in pregnant females. On Day 14 all dams were subjected to Caesarian section and the number of implantation sites, resorption sites, live fetuses, dead fetuses, and body weight of live pups were recorded. Gestation index, mortality, gross pathology incidence of the dam urogenital tract, number of implantation sites, number of corpora lutea, litter size and weights, sex and sex ratio of pups, and gross abnormalities to pups were reported (these data were described in the robust summary for reproductive effects for the test material). The urogenital tract of each dam was examined for anatomical abnormalities. One-third of fetuses of each litter underwent detailed visceral examination at 10x magnification. The remaining two-thirds were stained with alizarin red S dye/KOH and examined for skeletal defects (the maternal and developmental fetal effects are discussed in this robust summary).
NOAEL (NOEL) maternal toxicity	600 mg/kg bw/day
NOAEL (NOEL) developmental toxicity	600 mg/kg bw/day
Actual dose received by dose level and sex	0, 6, 28, 130, or 600 mg/kg bw of the test material (FDA 71-28)
Maternal data with dose level	Daily clinical observation and measurement of body weight gain failed to show any differences between control and test groups of female rats. The number pregnant and % pregnancy were similar for all dose and control groups. One pregnant female died in each of the two control groups and the two highest dose groups in the study. No abortions were observed in any group.
Fetal Data with Dose Level	The average fetal weight of treatment and control groups were not statistically different ($p>0.05$). The total number of live fetuses was similar for test and control groups. A small % of (less than 3%) dead fetuses were observed at the three highest dose levels. Skeletal examination of sternebrae showed no significant differences in the incidence of incomplete ossification or missing sternebrae for test and control groups. Likewise the incidences of fetuses with more than 13 ribs, incomplete ossification of vertebrae and extremities, incomplete skull closures were similar for test and control animals. Visceral examination failed to reveal any evidence of abnormalities at any dose level.
Conclusion Remarks	There was no evidence of maternal toxicity or developmental toxicity at dose levels up to and including 600 mg/kg bw/day of test material.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
References	Morgareidge K. (1973b) Teratologic evaluation of FDA 71-28 in hamsters. Contract No. FDA 71-260. Unpublished Report.

Substance Name	*alpha*-Pinene
CAS No.	80-56-8
Remarks for Substance	The test substance was rowachol which is a terpene mixture and contains *alpha*/*beta*-pinene (17%), l-menthol (32%), menthone (6%), borneol (5%), d-camphene (5%), cineol (2%), rheochrysin(0.1%). The vehicle was olive oil (32.9%).
Method/guideline	In vivo teratology toxicity screening test
Test Type	In vivo mammalian test system
GLP	Pre-GLP
Year	1978
Species/strain	Rat/Sprague-Dawley
Sex	Female
Route of Administration	Oral (gavage)
Duration of Test	20 days
Doses/concentration Levels	0, 0.16, 0.8, 1.6 ml/kg (0, 137.6, 688, 860 mg/kg)
Exposure Period	5 days
Frequency of Treatment	Daily
Control Group and Treatment	0.8 ml/kg (688 mg/kg) olive oil
Remarks for Test Conditions	The test substance was administered orally by gavage at the dose levels specified or the vehicle alone once daily for six days from the 9th to 14th day of gestation. All dams were necropsied and examined for gross lesions on Day 20.
NOAEL (NOEL) maternal toxicity	0.8 ml/kg (688 mg/kg)
LOAEL (LOEL) maternal toxicity	1.6 ml/kg (860 mg/kg)
NOAEL (NOEL) developmental toxicity	0.8 ml/kg (688 mg/kg)
LOAEL (LOEL) developmental toxicity	1.6 ml/kg (860 mg/kg)
Maternal data with dose level	No significant differences were reported for maternal body weight gain, number of implantations, placental weight, intrauterine mortality and fetal weight for the 0.16 (137.6 mg/kg) and 0.8 ml/kg (688 mg/kg) dose levels. At the 1.6 ml/kg (860 mg/kg) dose level, significant maternal weight loss and placental and fetal weight loss were reported.
Fetal Data with Dose Level	No gross, visceral or skeletal anomalies were reported at the highest dose level. Malformations were reported in the 0.16 ml/kg (137.6 mg/kg) dose group and the control group, but the differences between the two were not significant. No effect on postnatal development was reported for the 0.16 (137.6 mg/kg) and 0.8 ml/kg (688 mg/kg) dose levels. Newborn body weight showed significant decrease at the 1.60 ml/kg (860 mg/kg)

	dose level, but development recovered within one week.
Statistical Evaluation	Yes
Remarks for Results	Given the recovery of the newborn body weight, the authors concluded there were no teratogenic effects of the test substance at any of the dose levels administered to rats.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Comparable to guideline study with acceptable restrictions. Data were acquired prior to GLP or OECD guidelines but were obtained by standard methodology and published in a peer reviewed journal.
References	Hasegawa M. and T. Toda (1978) Teratological studies on rowachol. Oyo Yakuri, 15(7), 1109-1119.

Substance Name	*beta*-Pinene
CAS No.	127-91-3
Remarks for Substance	The test substance was rowachol which is a terpene mixture and contains *alpha*/*beta*-pinene (17%), l-menthol (32%), menthone (6%), borneol (5%), d-camphene (5%), cineol (2%), rheochrysin(0.1%). The vehicle was olive oil (32.9%).
Method/guideline	In vivo teratological toxicity screening test
Test Type	In vivo mammalian test system
GLP	Pre-GLP
Year	1978
Species/strain	Rat/Sprague-Dawley
Sex	Female
Route of Administration	Oral
Duration of Test	20 days
Doses/concentration Levels	0, 0.16, 0.8, 1.6 ml/kg (0, 137.6, 688, 860 mg/kg)
Exposure Period	5 days
Frequency of Treatment	Daily
Control Group and Treatment	0.8 ml/kg (688 mg/kg) olive oil
Remarks for Test Conditions	The test substance was administered orally at the dose levels specified or the vehicle alone once daily for six days from the 9th to 14th day of gestation. All dams were necropsied and examined for gross lesions on Day 20.
NOAEL (NOEL) maternal toxicity	0.8 ml/kg (688 mg/kg)
LOAEL (LOEL) maternal toxicity	1.6 ml/kg (860 mg/kg)

NOAEL (NOEL) developmental toxicity	0.8 ml/kg (688 mg/kg)
LOAEL (LOEL) developmental toxicity	1.6 ml/kg (860 mg/kg)
Maternal data with dose level	No significant differences were reported for maternal body weight gain, number of implantations, placental weight, intrauterine mortality and fetal weight for the 0.16 (137.6 mg/kg) and 0.8 ml/kg (688 mg/kg) dose levels. At the 1.6 ml/kg (860 mg/kg) dose level, significant maternal weight loss and placental and fetal weight loss were reported.
Fetal Data with Dose Level	No gross, visceral or skeletal anomalies were reported at the highest dose level. Malformations were reported in the 0.16 ml/kg (137.6 mg/kg) dose group and the control group, but the differences between the two were not significant. No effect on postnatal development was reported for the 0.16 (137.6 mg/kg) and 0.8 ml/kg (688 mg/kg) dose levels. Newborn body weight showed significant decrease at the 1.60 ml/kg (860 mg/kg) dose level, but development recovered within one week.
Statistical Evaluation	Yes
Remarks for Results	Given the recovery of the newborn body weight, the authors concluded there were no teratogenic effects of the test substance at any of the dose levels administered to rats.
Data Qualities Reliabilities	Reliability code 2. Reliable with restrictions.
Remarks for Data Reliability	Comparable to guideline study with acceptable restrictions. Data were acquired prior to GLP or OECD guidelines but were obtained by standard methodology and published in a peer reviewed journal
References	Hasegawa M. and T. Toda (1978) Teratological studies on rowachol. Oyo Yakuri, 15(7), 1109-1119.

Substance Name	Camphene
CAS No.	79-92-5
Remarks for Substance	Camphene (78%)
Method/guideline	OECD Guideline 414
GLP	Yes
Year	1992
Species/strain	Rat/Sprague-Dawley
Sex	Female
Route of Administration	Gavage
Doses/concentration Levels	0, 250, 1000 mg/kg bw/day
Exposure Period	Days 6 to 15 of gestation
Frequency of Treatment	Daily

Control Group and Treatment	Yes, concurrent, no treatment
Remarks for Test Conditions	20 animals/group
NOAEL (NOEL) maternal toxicity	250 mg/kg bw
NOAEL (NOEL) developmental toxicity	1000 mg/kg bw
Remarks for Results	No maternal mortalities were reported at any dose level. Clinical symptoms include reduced motor activity and salivation in 6 of 20 dams in the high dose group after the first or second dose. At 1000 mg/kg bw, there was a slight but not statistically significant increase (11.5%) in resorption rate compared to the control group (5.2%). No teratogenic effects were observed in any dose group.
Data Qualities Reliabilities	Reliability code 1. Reliable without restrictions.
Remarks for Data Reliability	The study was performed according to OECD Guideline 414.
References	Hoechst AG (1992) LPT Laboratory of Pharmacology and Toxicology, Report No. 7263/92 (HOE 92.1167) and Report No. 7114/91.